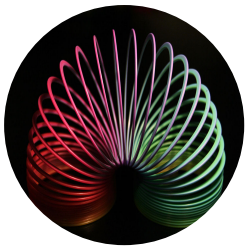


Beyond the Slinky®, Part 1

Qualitative Characteristics of Waves

Danny Mattox, Bj Sneed, Heather Shaffery, Anna Rodriguez
Published by *K20 Center*

Grade Level	6th – 12th Grade	**Time Frame**	150 minutes
Subject	Science	**Duration**	2-4 class periods
Course	Chemistry, Physical Science		

Essential Question

What is a wave?

Summary

In this lesson, students will investigate the qualitative characteristics of waves. The next lesson in this three-part series focuses on the quantitative characteristics of waves.

Snapshot

Engage

Students predict the heating pattern in a microwave and then see if their predictions are correct.

Explore

Students investigate waves in a series of stations set up around the classroom.

Explain

Students discuss what they observed at the stations as a class.

Extend

Students complete a Card Sort activity to learn about the wavelengths of the electromagnetic (EM) spectrum and the frequency and amplitude of sound waves.

Evaluate

Students use the Claim, Evidence, Reasoning (CER) strategy to revise their original thoughts on how microwaves work.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

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.

Next Generation Science Standards (Grades 6, 7, 8)

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

Oklahoma Academic Standards (8th Grade)

8.PS2.2.2: The greater the mass of the object, the greater the force needed to achieve the same change in motion.

Oklahoma Academic Standards (8th Grade)

CH.PS2.6.1: Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Oklahoma Academic Standards (8th Grade)

PH.PS3.3 : Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*

Attachments

- 3-2-1-Beyond-the-Slinky-R-Part-1 - Spanish.docx
- 3-2-1-Beyond-the-Slinky-R-Part-1 - Spanish.pdf
- 3-2-1-Beyond-the-Slinky-R-Part-1.docx
- 3-2-1-Beyond-the-Slinky-R-Part-1.pdf
- Card-Sort-Key-Beyond-the-Slinky-R-Part-1.pdf
- Card-Sort-With-Cut-Lines-Beyond-the-Slinky-R-Part-1.pdf
- Claim-Evidence-Reasoning-CER-Beyond-the-Slinky-R-Part-1 - Spanish.docx
- Claim-Evidence-Reasoning-CER-Beyond-the-Slinky-R-Part-1 - Spanish.pdf
- Claim-Evidence-Reasoning-CER-Beyond-the-Slinky-R-Part-1.docx
- Claim-Evidence-Reasoning-CER-Beyond-the-Slinky-R-Part-1.pdf
- Lesson-Slides-Beyond-the-Slinky-R-Part-1.pptx
- Microwave-Demonstration-Beyond-the-Slinky-R-Part-1 - Spanish.docx
- Microwave-Demonstration-Beyond-the-Slinky-R-Part-1 - Spanish.pdf
- Microwave-Demonstration-Beyond-the-Slinky-R-Part-1.docx
- Microwave-Demonstration-Beyond-the-Slinky-R-Part-1.pdf
- Wave-Stations-Beyond-the-Slinky-R-Part-1 - Spanish.docx
- Wave-Stations-Beyond-the-Slinky-R-Part-1 - Spanish.pdf
- Wave-Stations-Beyond-the-Slinky-R-Part-1.docx
- Wave-Stations-Beyond-the-Slinky-R-Part-1.pdf

Materials

- Lesson Slides (attached)
- Microwave Demonstration handout (attached; one per student)
- Wave Stations handout (attached; one per student)
- 3-2-1 handout (attached; one half-sheet per student)
- Card Sort With Cut Lines (attached; one card set per student pair)
- Card Sort Key (attached)
- Claim, Evidence, Reasoning (CER) handout (attached; one per student pair)
- Microwave oven
- Cardboard, cut into a square to fit in the bottom of the microwave

- Giant chocolate bars, refrigerated
- Wax paper
- Metal hanger
- String/twine
- Pencils
- Pie plates
- Tuning forks
- Prism
- Water
- Styrofoam cups
- Paper clips
- Eyedropper
- Rulers
- Rubber bands of various sizes/thickness
- Scissors
- Flashlight (non-LED works best)
- Straws

Engage

Teacher's Note: Lesson Preparation

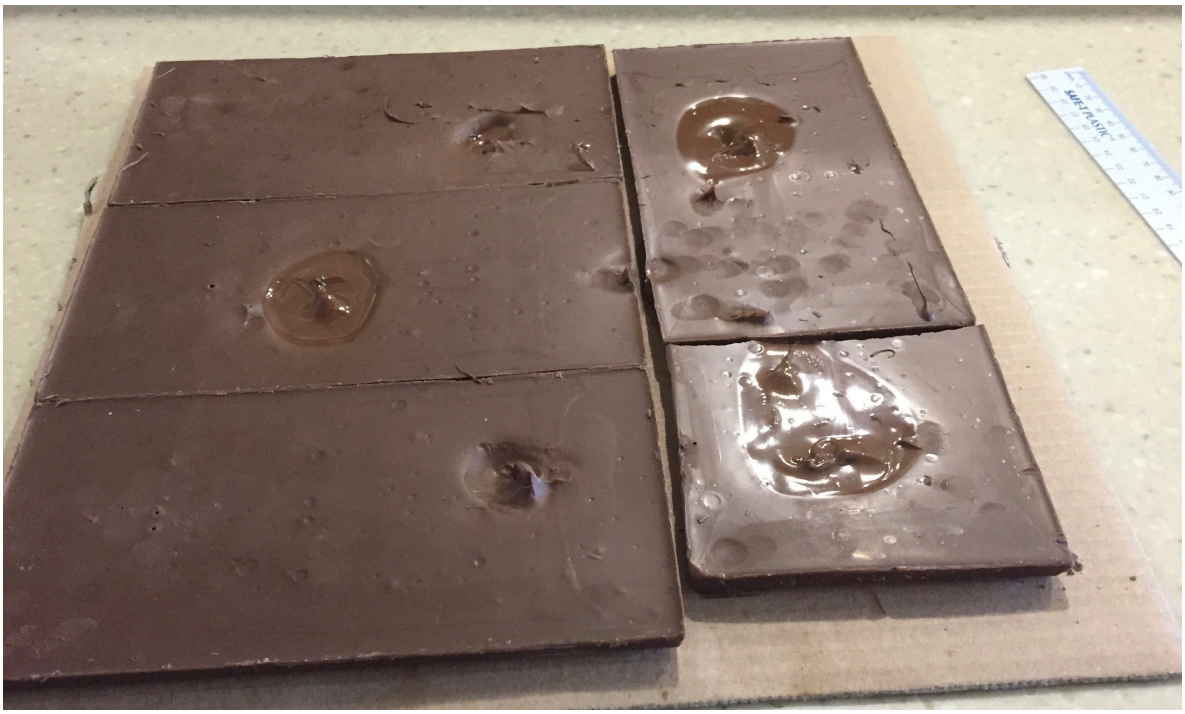
1. Purchase 3–5 giant chocolate bars and keep them refrigerated. Giant bars work better for the demonstration because they are thicker.
2. Set up the microwave for the chocolate demonstration. For the demonstration to work, it is vital that the chocolate does not rotate inside. Cut out a square of cardboard that fits in the bottom of your microwave so that any food sitting on it does *not* rotate when the microwave is turned on.
3. Set up the wave stations for the Explore activity. See the attached **Wave Stations** handout for directions on station setup and details about the required materials.
4. Prepare the cards for the Card Sort activity in the Extend portion of the lesson. Print the attached **Card Sort With Cut Lines** and cut out the cards along the dotted lines, then use paper clips or envelopes to organize the cards. You will need to prepare one card set for each pair of students.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to share the essential question and go to **slide 4** to review the lesson objectives with students.

Go to **slide 5**. Pass out the attached **Microwave Demonstration** handout to each student.

1. Make sure the microwave is set up as described in the note above.
2. Ask students to draw a diagram of the microwave and depict how things are heated inside.
3. Place 3–5 refrigerated chocolate bars on a sheet of wax paper, then place them on the cardboard in the microwave. The chocolate should cover most of the cardboard so that you can see the heating pattern clearly.
4. Reduce the microwave's power. If your microwave uses a power scale of 1–10, choose a setting of 3–4, or 30–40 percent of the microwave's total power.
5. Ask students to draw and label the chocolate and the cardboard. Then, have students write one or two sentences to predict what will happen when the chocolate is microwaved at lower power while not rotating.
6. Turn on the microwave for 10–15 seconds.
7. Check the chocolate for melted spots.
8. Repeat steps 6 and 7 until there are some obviously melted spots in the chocolate.
9. Mark the melted spots with a toothpick and measure the distance between melted spots.
10. Without offering an explanation, discuss the results with the class.

This is what the chocolate looks like before turning on the microwave.



This is what the chocolate should look like after being microwaved.

Explore

Display **slide 6** and pass out the attached **Wave Stations** handout to each student. Inform students they will rotate around the classroom, investigating sound and EM waves at several different stations.

Teacher's Note: Stations

The handout includes materials and procedure information, as well as analysis questions, for eight lab stations. You may choose to have students do some or all stations, but it is recommended that, at minimum, students complete the Rubber Bands, Tuning Forks, and Prisms stations. Also note that Station 3: Paper Cup Phone is used in Part 3 of the "Beyond the Slinky®" lesson series, so save that station for later if you plan to complete all three lessons.

See below for a brief description of each station:

1. Tuning Forks: Students listen to tuning forks and observe how they affect water.
2. Coat Hanger Apparatus: Students observe how waves transfer through different objects.
3. Paper Cup Phone: Students transmit messages through a taut string.
4. Petri Dish Water Waves: Students create water waves (ripples) and observe wave convergence.
5. Rubber Bands: Students observe how the thickness and the degree to which a rubber band is stretched affect the pitch of the sound it makes.
6. Metric Ruler Vibrations: Students create mechanical waves and observe the behavior of the end of a ruler.
7. Straws: Students investigate how changing the length of a straw alters the sound it produces.
8. Prisms: Students use a prism to split light and see a rainbow.

Teacher's Note: Keep It Simple

The goal of this lesson is for students to collect qualitative data about waves; they will shift their focus to quantitative data in Part 2 of this lesson series. With this in mind, though it might be tempting to have students take measurements so they can perform calculations, don't include that just yet. Keep the focus of this lesson on the basic traits of waves and this will allow students to build their knowledge gradually.

Explain

Display **slide 7**. Once student groups have completed all the stations, briefly discuss the findings from each.

Go to **slide 8** and give each student one half-sheet from the attached **3-2-1** handout. Using the 3-2-1 strategy, have students write three things all the stations had in common, two differences they observed among the various stations, and one question they still have about waves. Solicit answers from the class for each of the 3-2-1 prompts.

Sample Student Responses

Students might struggle with determining how the light and prism stations relate to the other stations, so the differences they observe and the questions they have during the 3-2-1 activity might reflect this uncertainty. Let students know the upcoming Card Sort activity will help to clarify the relationship among the stations.

Extend

Teacher's Note: Card Sort Preparation

Remember to cut out the Card Sort sets before class using the attached **Card Sort With Cut Lines**. You may need to explain to students that the objects included in the Card Sort are simply representations meant to help them with size comparison.

Display **slide 9** and pair up students. Inform students they will complete a Card Sort to learn more about the electromagnetic spectrum.

Pass out one Card Sort set to each student pair. The cards consist of three different categories: wave (arrange by length), name of wave (arrange by numerical size), and object (arrange by size). Ask students to organize the cards into sets of wave, name, and object, then arrange the sets in what they think is the correct order from longest to shortest.

Go to **slide 10** to show students the correct arrangement of the cards. You may print the attached **Card Sort Key** if you wish to provide students with paper copies of the correct arrangement.

Evaluate

Display **slide 11**. Pass out the attached **Claim, Evidence, Reasoning (CER)** handout to each student pair.

Using the Claim, Evidence, Reasoning (CER) strategy, have student pairs provide evidence from their observations to justify the following claim: *To heat food evenly, a microwave needs a rotating plate.*

Remind students they must use scientific reasoning to explain (1) why this happens and (2) how the evidence justifies the claim.

Teacher's Note: Scaffolding

If students are struggling to construct their CER arguments, consider moving to **slide 12** to show them the video "Finding the Speed of Light With Peeps." If scaffolding the activity in this way doesn't seem necessary at this point in the lesson, you may hide the slide or skip it during the presentation.

Embedded video

https://youtube.com/watch?v=HwREvdUWSKE

Resources

- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5059a7b
- K20 Center. (n.d.). Card Sort. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506976b
- K20 Center. (n.d.). Claim, Evidence, Reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506fc09
- Lau, E. (2006, July 22). Slinky rainbow [Image]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Slinky_rainbow.jpg
- NPR's Skunk Bear. (2015, April 13). Finding the Speed of Light With Peeps [Video]. YouTube. https://www.youtube.com/watch?v=HwREvdUWSKE
- Slay, J. (n.d.). Electromagnetic spectrum [Image]. NASA's Imagine the Universe. teacherlink.ed.usu.edu/tlnasa/reference/imaginedvd/files/imagine/docs/science/try_l2/emspectrum
- University of Illinois Extension. (2014, September 15). Visible Spectrum of Light [Video]. YouTube. https://www.youtube.com/watch?v=MX2gUpYTPls&feature=youtu.be