

What Is a Wave? Lesson 5

New Direction

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Grade Level	9th – 10th Grade	**Time Frame**	90 minutes
Subject	Social Studies	**Duration**	2 class periods
Course	Physical Science		

Essential Question

What are waves? How do waves behave differently from particles?

Summary

In this fifth and final lesson of the "What Is a Wave?" unit, students will observe two demonstrations of waves interacting with different types of matter and form conclusions to understand how light travels through matter. Students will complete a Concept Card Map activity to demonstrate their understanding of the unit's content and concepts.

Snapshot

Engage

Students generate key concepts based on the previous lessons.

Explore

Students make observations and develop claims about light traveling through matter.

Explain

Students observe a laser demonstration and form conclusions about light frequency.

Extend

Students brainstorm other forms of radiation.

Evaluate

Students create a Concept Card Map to summarize their understanding of the unit.

Standards

Oklahoma Academic Standards (Physical Science)

PS.PS4.1 : Use mathematical representations to explain both qualitative and quantitative relationships among frequency, wavelength, and speed of waves traveling in various media.
PS.PS4.4 : Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
PS.PS4.4.1: When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat).
PS.PS4.4.2: Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
PS.PS4.4.3: Photoelectric materials emit electrons when they absorb light of high enough frequency.

Attachments

- CERTIfy Your Thinking Activity—New Direction - Spanish.docx
- CERTIfy Your Thinking Activity—New Direction - Spanish.pdf
- CERTIfy Your Thinking Activity—New Direction.docx
- CERTIfy Your Thinking Activity—New Direction.pdf
- Concept Card Packet Waves—New Direction - Spanish.docx
- Concept Card Packet Waves—New Direction - Spanish.pdf
- Concept Card Packet Waves—New Direction.docx
- Concept Card Packet Waves—New Direction.pdf
- Lesson Slides—New Direction.pptx
- Wave Vocabulary Packet—New Direction - Spanish.docx
- Wave Vocabulary Packet—New Direction - Spanish.pdf
- Wave Vocabulary Packet—New Direction.docx
- Wave Vocabulary Packet—New Direction.pdf
- Wave Vocabulary Teacher Guide—New Direction.docx
- Wave Vocabulary Teacher Guide—New Direction.pdf

Materials

- Lesson Slides (attached)
- Concept Card Packet (attached; one per group of 3-4 students)
- C.E.R.T.I.fy Your Thinking Activity (attached; one per student)
- Wave Unit Vocabulary Packet (attached; one per student)
- Wave Unit Vocabulary Teacher's Guide (attached)
- Yellow highlighter
- Pliers
- Jar with lid
- Two liter clear plastic bottle
- Drinking glass
- Pencil
- Water
- 650nm red laser pointer
- 405nm blue/violet laser pointer
- Poster board or large paper
- Glue sticks

15 minutes

Engage

Use the attached **Lesson Slides** to guide the lesson.

Show **slides 3 and 4**. Review the essential questions and lesson objectives with students. Place students into groups of three or four.

Show **slide 5**. Using the Strike Out strategy:

1. Ask students to generate a list of key ideas or themes from the past two lessons in this unit.
2. When the lists are complete, have each group pass their list to another group for review.
3. Instruct each group to strike out the least important key concept from the lists they review.
4. Have the students pass to another group and repeat step 3.
5. When each group receives its original list, ask students look it over and choose one concept to reclaim.
6. Instruct groups to add the reclaimed concept back to their original list.

Show **slide 6.** Ask students to combine their lists of important themes and concepts gleaned from the past two lessons. Have them add these concepts to the Strike Out Board created in Lesson 2.

Show **slide 7**. Refer to the Driving Question Board created in Lesson 1. Ask students to determine if any of their questions can be answered at this time and include any questions that should be added at this time.

20 minutes

Explore

Teacher's Note: Activity Preparation

Get a clear glass, a bottle of water, and a pencil.

Show **slide 8.** Pass out the attached **C.E.R.T.I.fy Your Thinking Activity** handout to each student. Introduce them to the C.E.R.T.I.fy Your Thinking strategy.

1. Show students the empty glass with the pencil inside the glass.
2. Ask students to think about how adding water to the glass will affect the way they see the pencil.
3. Have students write a response on their handout. This response is their *claim*.
4. Invite them to consider what they have learned about waves so far.
5. Based on what they already know, have students write a sentence with *evidence* for their response.
6. Have students write their *reasoning* for their claim.
7. Ask for volunteers to share their *claims*, *evidence* and *reasoning*.

Show **slide 9** after students have written a *claim*, *evidence*, and *reasoning* on their activity sheet. Add water to the glass and tell students to observe the pencil.

Show **slide 10.**

1. Ask students if their claim has changed after viewing the pencil with water in the glass.
2. Have students write a new claim in the next box on their handout.
3. If their evidence has changed based on observing the pencil in the water, have students provide a new piece of evidence as well as a new reasoning.
4. Ask for volunteers to share their revised claims, evidence, and reasoning.

Explain to students that the pencil appears to be crooked because light cannot travel as quickly in water as it does in the air; therefore, the light bends around the pencil and makes it appear crooked.

Tell students that this is an example of "refraction" and that they will learn more about refraction during this lesson.

20 minutes

Explain

Teacher's Note: Use Caution While Preparing the Lasers

Dim the lights in the classroom. Ensure that lasers are pointed away from observers and that there are no reflections back into the eyes of observers.

Teacher's Note: Activity Preparation

Watch this video, titled "How to Make Fluorescent Water (UV Reactive)."

Embedded video
https://youtube.com/watch?v=ULgTrw63Tn4

Prepare a clear, two-liter container of "glow water" before class. To prepare "glow water," use the following steps:

1. Using pliers, pull the bottom end out of a full-sized yellow fluorescent highlighter.
2. Remove the dye wick from the highlighter.
3. Cut open the dye wick to expose the dye.
4. Remove the writing tip from the highlighter as well.
5. Place both the writing tip and dye wick into a glass jar with a lid.
6. Shake or swirl the container for 30 seconds.
7. Let the jar sit for at least 10 minutes, which will extract the dye into the water.
8. Pour the prepared liquid into a two liter bottle with the label removed.
9. Fill up the remainder of the bottle with water.

Show **slide 11**. Shine a 650nm red laser pointer through the glow water. Ask students to share what they observe. No fluorescence should appear. Note that the red laser passes directly through the glow water and appears on the other side of the bottle. This can be done by holding up a white card behind the bottle.

Show **slide 12.** Shine a 405nm blue/violet laser through the glow water. Ask students to share what they observe. The water should fluoresce a bright yellow/green color.

Suggest to students that perhaps two red laser pointers will make the water fluoresce. Shine two red laser pointers at one time into the bottle. Ask students to share why the blue/violet laser produces a change, but the red lasers do not. Explain that red lasers have a lower frequency than blue/violet lasers, so regardless of how many red lasers are shined into the water, it will not result in a fluorescence.

Also note that the blue laser does not pass through the glow water. It is completely absorbed by the process of fluorescence. A white card can also be used to show that no blue light appears on the other side of the bottle.

Move to **slide 13** and pose the question, "How do electromagnetic waves interact with matter?" to your students. At this time your students should have a good understanding of EM waves and how they react. They may not know the academic vocabulary at this point, but they should be able to share that at least one of four things can happen when EM radiation interacts with matter:

1. Waves do not penetrate and are reflected
2. Waves are transmitted through the material with little energy loss
3. Energy from the waves is absorbed by the material and the waves disappear
4. Energy from the waves is absorbed, then converted to heat energy or emitted as new EM waves of a different frequency

Tell students to use their copy of the attached **Wave Vocabulary Packet** for taking notes while reviewing the definitions on the following terms. By this time in the unit, students should have notes and examples for most of the terms on the handout. Students can add notes to their vocabulary packets at this time. Ask students to review their vocabulary words to make sure they have filled in all the boxes on the handout. Discuss any questions they may have about their vocabulary words.

Possible Student Responses

See the attached **Wave Vocabulary (Teacher's Guide)** for a key with student responses.

Show **slide 14** and share the definition of Reflection. You'll want to make sure and share the following information with your students as well.

- Many materials will cause light to bounce off their surface. This "bouncing off" is called reflection.
- When reflection occurs, little to none of the light enters the material.
- Even "dull" looking materials reflect light. If you can see it, it is reflecting.
- Color is determined by reflection. For example, a red object reflects red light but absorbs other colors.

Show **slide 15** and share the definition of Transmission. You'll want to make sure and share the following information with your students as well.

- Many materials allow light to pass through while absorbing virtually no energy from them.
- These materials look clear and are *transparent.*
- *Translucent* materials allow light to pass through, but scatter the wave direction, making the material look cloudy

Show **slide 16** and share the definition of Refraction. You'll want to make sure and share the following information with your students as well.

- When light travels from a less dense medium into a more dense medium (air into water, for example) its speed and wavelength both slightly decrease. But its frequency (color) remains unchanged.
- A change in the direction of light always accompanies this speed/wavelength change. When this happens, the path of the waves appears to bend. We call this bending *refraction.*

Show **slide 17** and play the video, titled "Refraction Explained."

Embedded video

https://youtube.com/watch?v=zarxpu43-ls

After the video, discuss the remaining vocabulary words on each of the upcoming slides.

Show **slide 18** and share the definition of Absorption. You'll want to make sure and share the following information with your students as well.

- Absorption occurs when matter absorbs the energy contained in EM waves. Total absorption results in all of the energy being transferred to the matter, with the EM wave vanishing.

Show **slide 19** and share the definition of Emission. You'll want to make sure and share the following information with your students as well.

- Emission is a special property of some materials that is observed when they absorb EM waves.
- Fluorescent materials absorb energy from EM waves. This excess energy causes the material to emit new EM waves with a lower energy and different color than what was absorbed.
- In our demonstration the light from the red laser did not have enough energy to trigger emission. It passed right through the dye. The light from the blue laser has much higher energy and triggered the emission of bright yellow/green light. All of the blue light was absorbed in this process.
- Materials react differently to EM radiation depending on how much energy it contains.

15 minutes

Extend

Show **slide 20**.

Assign students to work in groups of 3-4 to develop a list of other types of electromagnetic radiation that have not been discussed so far. Have them write their notes on notebook paper. Ask each group to share one type of electromagnetic radiation they have discussed in their groups.

Possible Student Responses

Students might share that radiation is used to treat cancer. Students might discuss how radiation is sometimes leaked from nuclear power plants, such as Fukushima Daiichi in Japan or in Chernobyl, Ukraine, when it was part of the Soviet Union.

30 minutes

Evaluate

Teacher's Note: Activity Preparation

Students will need glue sticks and either poster board or large pieces of butcher paper to complete this activity.

Show **slide 21.** Introduce the Concept Card Mapping strategy to students. Ask students to return to their groups of 3-4. Pass out the attached **Concept Card Packet** to each group.

Provide time for students to sort the concept cards and to decide how the cards should be connected to each other. Encourage students to use their vocabulary packets to assist with grouping the concept cards. Have students glue or paste their concept cards to the poster board and draw lines to show connections among the cards.

Collect the completed mapping poster to assess students' understanding of the unit content.

Optional Unit Evaluate

Use a resource, such as released work from the OSTP (Oklahoma State Testing Program) or The Wonder of Science, to help prepare your students for the end-of-the-year assessment.

Resources

- Electronics Projects - Stephano91ste. (n.d.). How to make fluorescent water (UV reactive) [Video]. YouTube. https://www.youtube.com/watch?v=ULgTrw63Tn4
- Fehrmann. (n.d.). The fluorescent lamp [Digital Image]. https://fehrmann.com.br/site/noticias/detalhes/a-lampada-fluorescente
- Kamenícek, J. (2014, March 31). London Millennium Bridge from Saint Paul's [Image]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:London_Millennium_Bridge_from_Saint_Paul%27s.jpg
- K20 Center. (n.d.). Driving Question Board. Strategies. https://learn.k20center.ou.edu/strategy/1511
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- K20 Center. (n.d.).C.E.R.T.I.fy Your Thinking. Strategies. https://learn.k20center.ou.edu/strategy/827
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- Pxleyes.com (n.d.). Light refraction [Digital Image]. http://www.pxleyes.com/photography-picture/500ab33be9af2/Light-refraction.html
- Science Sauce. (2019, October 29). Refraction explained [Video]. YouTube. https://www.youtube.com/watch?v=zarxpu43-ls