

Diffraction Unit, Lesson 3: Wonky Waves

The Doppler Effect

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Grade Level	9th – 12th Grade	**Time Frame**	90–120 minutes
Subject	Science	**Duration**	2–3 periods
Course	Chemistry, Physics		

Essential Question

How do you know if a siren is moving toward or away from you?

Summary

In this lesson, students will explore the Doppler effect. They will practice by using a Doppler ball and the Doppler equation. Students will also learn how the Doppler effect is useful in our everyday lives with sirens and weather prediction.

Snapshot

Engage

Students generate questions from a video of a siren demonstrating the Doppler effect.

Explore

Students generate questions, test theories, and answer questions through a Doppler ball activity.

Explain

Students use the formula to answer questions about the Doppler effect.

Extend

Students research how the Doppler effect helps with weather prediction and create a research poster.

Evaluate

Students use a Choice Board to answer the essential question.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD304: Determine how the values of variables change as the value of another variable changes in a simple data presentation
IOD403: Translate information into a table, graph, or diagram
IOD404: Perform a simple interpolation or simple extrapolation using data in a table or graph
IOD504: Determine and/or use a simple (e.g., linear) mathematical relationship that exists between data
SIN301: Understand the methods used in a simple experiment
SIN401: Understand a simple experimental design

Oklahoma Academic Standards (Physics)

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

Attachments

- Choice Board—Wonky Waves - Spanish.docx
- Choice Board—Wonky Waves - Spanish.pdf
- Choice Board—Wonky Waves.docx
- Choice Board—Wonky Waves.pdf
- Doppler Ball Activity—Wonky Waves - Spanish.docx
- Doppler Ball Activity—Wonky Waves - Spanish.pdf
- Doppler Ball Activity—Wonky Waves.docx
- Doppler Ball Activity—Wonky Waves.pdf
- Doppler Equation—Wonky Waves - Spanish.docx
- Doppler Equation—Wonky Waves - Spanish.pdf
- Doppler Equation—Wonky Waves.docx
- Doppler Equation—Wonky Waves.pdf
- Generating Questions—Wonky Waves - Spanish.docx
- Generating Questions—Wonky Waves - Spanish.pdf
- Generating Questions—Wonky Waves.docx
- Generating Questions—Wonky Waves.pdf
- Lesson Slides—Wonky Waves.pptx
- Research Posters 3-2-1—Wonky Waves - Spanish.docx
- Research Posters 3-2-1—Wonky Waves - Spanish.pdf
- Research Posters 3-2-1—Wonky Waves.docx
- Research Posters 3-2-1—Wonky Waves.pdf
- Supplemental Questions—Wonky Waves - Spanish.docx
- Supplemental Questions—Wonky Waves - Spanish.pdf
- Supplemental Questions—Wonky Waves.docx
- Supplemental Questions—Wonky Waves.pdf

Materials

- Lesson Slides (attached)
- Generating Questions handout (attached; one per student)
- Doppler Equation handout (attached; one per student)
- Doppler Ball Activity handout (attached; one per group)
- Supplemental Questions handout (attached; optional)
- Research Poster 3-2-1 handout (attached; one per student)
- Choice Board handout (attached; one half-sheet per student; optional)
- Materials for choice board projects

- Doppler ball/Doppler ball supplies (one per group)
- Large paper (one per student/ group)
- Calculator (one per student)
- Student devices with internet access

Engage

Introduce the lesson using **slide 2** of the attached **Lesson Slides**.

Display **slide 3** to share the essential question and **slide 4** to go over the lesson's learning objectives as needed.

Move to **slide 5**. Share the Question Generating strategy with students and pass out a copy of the attached **Generating Questions** handout to each student. Have a whole-class discussion about the criteria for a "good" question. When everyone has agreed on two or three, write them on the board or edit slide 5 to include them. These will be the criteria students use as they generate questions.

Move to **slide 6**. Show the *Ambulance Screaming by at High Speed - Doppler Effect* video and instruct students to write down their generated questions as they go. Optionally, play the video more than once to give students more time to generate "good" questions.

Embedded video
https://youtube.com/watch?v=rqehO9yfwTA

Teacher's Note: Sensory Sensitivity

This video contains a loud siren, so be aware of students with sensory needs.

Explore

Teacher's Note: Lesson Preparation

Customize **slide 8** and the attached **Doppler Ball Activity** handout and change activity directions to fit your classroom norms, class size, and available materials. If Doppler balls are not available, follow the directions on the handout to construct homemade Doppler balls.

Suggested instructions:

1. Put students into groups of two to four.
2. Make sure students have enough room to toss/swing the ball at different speeds and distances.
3. Instruct students to answer their questions from the previous section and write down any new questions they have.
4. Allow students 10–15 minutes to investigate with their Doppler balls.

Display **slide 7** and introduce the Doppler Ball Activity. Pass out a copy of the attached Doppler Ball Activity handout to each group. Make sure students also have their Generating Questions handout from the previous activity. They will be adding new questions and answering the ones they already generated.

Move to **slide 8** and make sure each group has a Doppler ball**.** Display the directions for the activity, and start the timer embedded in the slide to begin. The timer included is for 10 minutes, but other times can be found on the K20 Center Timers playlist on YouTube if more time is needed.

Embedded video
https://youtube.com/watch?v=9gy-1Z2Sa-c

After the activity, move to **slide 9**. Share the image on the slide with students. Guide them in a discussion about the image and the questions and answers they discovered during the Doppler ball activity. For an alternative image, use the one featured on **slide 15**.

Optional Video

Slide 10 contains the optional *Doppler Effect By Dr. Sheldon Cooper* video for students.

Embedded video
https://youtube.com/watch?v=o3G_eaSaLck

Explain

Optional Supplemental Content

Some students may need a refresher on how to use the formula before beginning the handout. If so, use the attached **Supplemental Questions** handout to reinforce skills.

Move to **slide 11** and share the Doppler formula with students. Give each student a copy of the attached **Doppler Equation** handout.

Students can work with partners or individually and will need a calculator to complete the handout.

Extend

Display **slide 12** and introduce the Weather Doppler Research Activity. Explain the Research Poster strategy to students and share the link to the website titled *Weather Doppler*.

Ensure every student has the necessary materials to complete their Research Poster. Alternatively, students may use Google Slides or Google Drawings.

Provide students time to research how the Doppler effect is used to predict the weather and create their Research Poster.

Move to **slide 13** and introduce the 3-2-1 and Gallery Walk strategies. Pass out the attached **Research Poster 3-2-1** handout to each student. Have students walk around the room viewing other students' posters and filling out the 3-2-1 with what they learn from their peers.

Evaluate

Move to **slide 14** and explain to students that they will be using a Choice Board to determine how to show their answer to the essential question.

Explain the choices in the Choice Board embedded in the slide. Optionally, pass out a copy of the attached **Choice Board** handout to each student.

Give students time to choose their method and display their answer. When all students are finished, allow them to share their projects with the class.

Resources

- K20 Center. (n.d.). 3-2-1. Strategies. https://learn.k20center.ou.edu/strategy/117
- K20 Center. (n.d.). Gallery Walk. Strategies. https://learn.k20center.ou.edu/strategy/118
- K20 Center. (n.d.). Choice Board. Strategies. https://learn.k20center.ou.edu/strategy/73
- K20 Center. (n.d.). Generating Questions. Strategies. https://learn.k20center.ou.edu/strategy/167
- K20 Center. (n.d.). Research Poster. Strategies. https://learn.k20center.ou.edu/strategy/49
- Seacams. (2013, January 11). *Ambulance screaming by at high speed - doppler effect* [Video]. YouTube. https://www.youtube.com/watch?v=rqehO9yfwTA
- The Doppler Effect. Sketchplanations. (n.d.). https://sketchplanations.com/the-doppler-effect
- Tomdelier1995. (2013, January 10). *Doppler Effect by Dr. Sheldon Cooper* [Video]. YouTube. Retrieved July 20, 2022, from https://www.youtube.com/watch?v=o3G_eaSaLck