Unit 8-2 Sound Waves

Content Area: **Science**
Course(s): **Science 8**
Time Period: **MP1-2**
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Essential Questions

Unit Question How can a sound make something move?

Lesson 1 How does a sound source make something like this happen?

Lesson 2 What is happening when speakers and other music makers make sounds?

Lesson 3 Do all objects vibrate when they make sounds?

Lesson 4 How do the vibrations of the sound source compare for louder versus softer sounds?

Lesson 5 How do the vibrations from a sound source compare for higher-pitch versus lowerpitch sounds?

Lesson 6 How can any object make so many different sounds?

Lesson 7 What is actually moving from the sound source to the window?

Lesson 8 Do we need air to hear sound?

Lesson 9 How can we model sound traveling through a solid, liquid, or gas?

Lesson 10 What exactly is traveling across the medium?

Lesson 11 How does sound make matter around us move?

Lesson 12 What goes on in people’s ears so they can detect certain sounds?

Lesson 13 What transfers more energy, waves of bigger amplitude or waves of greater frequency?

Lesson 14 How can we explain our anchoring phenomenon, and which of our questions can we now answer?

Big Ideas

Unit Summary and Storyline

In this unit, students develop ideas related to how sounds are produced, how they travel through media, and how they affect objects at a distance. Their investigations are motivated by trying to account for a perplexing anchoring phenomenon — a truck is playing loud music in a parking lot and the windows of a building across the parking lot visibly shake in response to the music.

They make observations of sound sources to revisit the K–5 idea that objects vibrate when they make sounds. They figure out that patterns of differences in those vibrations are tied to differences in characteristics of the sounds being made. They gather data on how objects vibrate when making different sounds to characterize how a vibrating object's motion is tied to the loudness and pitch of the sounds they make. Students also conduct experiments to support the idea that sound needs matter to travel through, and they will use models and simulations to explain how sound travels through matter at the particle level.

Anchoring phenomenon

Students begin the sound unit by considering an interesting phenomenon: a truck is playing loud music in a parking lot and the windows of a building across the parking lot visibly shake in response to the music. Students generate questions about three aspects of sound phenomena: 1) What makes sound? 2) How does sound get from the truck to the window? 3) Why does the window shake like it does? Students engage in model-based reasoning, argumentation, and computational and mathematical reasoning to develop models to explain these three aspects of the mystery.

Each OpenScied unit's anchoring phenomenon is chosen from a group of possible phenomena after analyzing student interest survey results and consulting with external advisory panels. We also chose the truck and window phenomenon as the anchor for this unit for these reasons:

- This familiar phenomenon provides a rich context for students to engage with all the Disciplinary Core Ideas (DCIs) that are bundled with the Performance Expectations of the unit.
- Hearing loud sounds and sounds with different pitches are common experiences for students and allow students to draw on a wide range of students' own experiences with other related phenomena.
- The field test of this anchor produced driving question boards on which the majority of the students' questions and ideas for investigations/sources of data needed to answer those questions, were anticipated by the unit development team and were specifically targeted in the field test version of the storyline.

Enduring Understandings

NGSS Performance Expectations

- 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. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.]
- MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.

Disciplinary Core Ideas

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

Crosscutting Concepts

- Scale, Proportion, and Quantity: This unit intentionally develops this crosscutting concept. Students extend their understanding of phenomena happening at scales we cannot see by using a variety of tools to model and collect data about the vibrations that occur when objects make sounds, and how those sounds transfer energy across media. Lessons 4-6 involve students in novel uses of scale when they work with the teacher to figure out how to develop and experiment with a scaled up version of the phenomena so they can analyze non visible motions of objects making sound. They use the representations developed from using this scaled up object to explain how different sounds are produced. Additionally, students evaluate or help propose other ways of scaling objects throughout the unit in order to provide evidence of what is happening when sounds are made (e.g. slow-motion videos of instruments in lesson 2, laser in lesson 3, simulation in lesson 10). In lesson 13 students use proportional relationships to analyze information from numerical data and graphs of how the energy transferred by a vibration changes with the frequency vs. the amplitude of the vibration. This leads students to conclude that increases in amplitude have a greater effect on the energy transferred by a vibrating object than in frequency.
- Patterns: This crosscutting concept is key to the sensemaking in this unit. In Lessons 1-3 students begin by using patterns to identify cause and effect relationships about sound sources. In Lessons 4-6 they compare and contrast graphical representations of objects moving and identify patterns about how sound makers vibrate differently for low/high pitched or loud/soft sounds. In Lesson 8 students notice patterns across investigations that sounds can be heard when there is matter between them and the sound source and use this pattern to identify that matter is needed for sounds to travel. In Lesson 10 they measure visual patterns in rate change of compression bands to see how changes in frequency and amplitude at the sound source affect the rate of movement of matter in the system. In Lesson 13 they use charts and graphs to identify patterns in rates of change as they discover that energy is transferred differently for increases in frequency versus amplitude of vibrations.
- Energy and Matter: This crosscutting concept is key to the sensemaking in this unit. Students use what they figured out about energy transfer in prior units to figure out how the transfer of energy from a force causes a sound source to vibrate (lessons 2-6) which transfers energy to neighboring particles across a medium, and those particles collide with another object, transferring energy to make it move (lessons 7-14). Students track the transfer of energy across the system from the sound source to the sound detector.
- The following crosscutting concept is also key to the sensemaking in the unit:
    - Cause and Effect

Cross-Curricular Integration

Integration Area: Language Arts

W.AW.8.1. Write arguments on discipline-specific content (e.g., social studies, science, technical subjects, English/Language Arts) to support claims with clear reasons and relevant evidence.

W.IW.8.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

A. Introduce a topic clearly, previewing what is to follow; and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aid in comprehension.

B. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

C. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.

D. Use precise language and domain/grade-level- specific vocabulary to inform about or explain the topic.

E. Establish and maintain a formal style/academic style, approach, and form.

F. Provide a concluding statement or section (e.g., sentence, part of a paragraph, paragraph, or multiple paragraphs) that synthesizes the information or explanation presented.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

B. Support claim(s) with logical reasoning and relevant evidence, using relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.

C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.

D. Establish and maintain a formal or academic style, approach, and form.

E. Provide a concluding statement or section that follows from and supports the argument presented.

Activity:

The students will conduct and experiment that will test the strength of an object's gravitational pull. They will use an interactive to collect data. They will then use the CER method to support their claims with evidence. Finally, they will write a passage that will explain what is going on using direct evidence.

Integration Area: Math

7.RP.A. 1-3 Analyze proportional relationships and use them to solve real-world and mathematical problems.

Activity:

The students will use an interactive model to collect data on the relationship between the two types of energy. The students will then create a graphical representation of the data. They will then answer math based questions that explore the relationships between the two types of energy.

Language Arts Companion Standards:

W.IW.8.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

A. Introduce a topic clearly, previewing what is to follow; and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aid in comprehension.

B. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.

C. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.

D. Use precise language and domain/grade-level- specific vocabulary to inform about or explain the topic.

E. Establish and maintain a formal style/academic style, approach, and form.

F. Provide a concluding statement or section (e.g., sentence, part of a paragraph, paragraph, or multiple paragraphs) that synthesizes the information or explanation presented.

G. RL.CR.8.1. Cite a range of textual evidence and make clear and relevant connections to strongly support an analysis of multiple aspects of what a literary text says explicitly as well as inferences drawn from the text.

RL.MF.8.6. Evaluate the choices made (by the authors, directors or actors) when presenting an idea in different mediums, including the representation/s or various perspectives of a subject or a key scene in two different artistic mediums (e.g., a person's life story in both print and multimedia), as well as what is emphasized or absent in each work.

RL.IT.8.3. Analyze how particular elements of a text interact (e.g., how setting shapes the characters or plot, how ideas influence individuals or events, or how characters influence ideas or events) across multiple text types, including across literary and informational texts.

Activity:

Physics-Force & Motion: How does the motion of an object depend on the total sum of forces on the object? Read the personal narrative of the experiment. How do the sum of forces affect the rates at which the feather and bowling ball fall? Cite examples from the readings to support your claim. Plan an investigation that will provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. Write an explanatory essay using evidence from each text.

WHST 6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

RST 6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

RST 6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

RST 6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Activity:

Physics-Kinetic Energy: Utilizing the text as your primary source, analyze the information presented on the transfer of kinetic energy and the mass and speed of an object. Interpret various graphical displays of data describing the relationships between kinetic energy to the mass of an object and to the speed of an object. Write an essay that explains kinetic energy and compares and contrasts the relationships between kinetic energy, speed and mass. Cite specific examples from the text and use data from the graphics and charts.

Science and Engineering Practices

- Using Mathematics and Computational Thinking: This unit intentionally develops this practice. Mathematical reasoning is key to figuring out the phenomena throughout the unit. The development and analysis of mathematical representations plays a central role in student sensemaking. Lessons 4-6 involve students in novel uses of math representations when they work with the teacher to figure out how to develop and experiment with a scaled up version of the phenomena so they can analyze non visible motions of objects making sound. They represent an object's motion graphically and use these mathematical representations of position versus time graphs generated from the movement of an object making louder/softer and higher/lower pitch sounds to describe wave patterns (frequency and amplitude) and to figure out how objects making different sounds move. In lesson 10, students look at patterns in the rate of and spacing in between compression bands as a way to measure wavelengths depending on the initial frequency or amplitude. In lesson 13, students will apply their understanding of linear and nonlinear relationships to identify that the energy transferred does not increase in proportion to amplitude and that increasing amplitude increases energy transfer more than increasing frequency. If students have studied exponential relationships they can further characterize the non linear relationship in the graph for amplitude vs energy transferred as an exponential relationship. Students also have the opportunity to construct equations to describe the relationships between these variables in algebraic terms (i.e., energy is related to the amplitude squared)
- Engaging in Argument from Evidence: This practice is key to the sensemaking students do in this unit. Students construct written and oral arguments throughout Lesson Sets 1 and 2. Students construct arguments from evidence about whether all objects
- vibrate when they make sounds; to support an explanation for which patterns of frequency and amplitude of a wave are related to sounds that we can hear; and whether matter is traveling all the way from the speaker to the window. They compare claims about whether air is needed for sound to travel to where we can hear it and use evidence from their investigations to select and defend one of these claims. Students provide critiques about their classmates' explanations and models and respond to those critiques by citing relevant evidence from their investigations and revising their explanations and models.
- Developing and Using Models: This practice is key to the sensemaking students do in this unit. Although no new elements of this practice are introduced, students use models to make sense of and

explain almost every aspect of what they figure out in this unit. Students have frequent opportunities to develop and revise models with a partner, in small groups, or as a class when they are making sense of new science ideas.
- The following practice is also key to the sensemaking in the unit:
    - Analyzing and Interpreting Data

CSDT Technology Integration

8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (eg, physical prototype; graphical/technical sketch)
Action: This is a station activity where the students make observations about energy. They have a computer-based lab lab activity on Gizmos (https://gz.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=405) where they identify the energy used to make objects move. They watch videos and take notes on a PowerPoint. They also work on an interactive where they have to maximize the input and output of kinetic and potential energy. During this activity, they have to create a rollercoaster that optimizes energy transfer. Data needs to be collected and put into a spreadsheet. Graphs need to be created to show data. The final stations were interpersonal discussions with the teacher and a conference with another group.

Science and Society

Nicolaus Copernicus

A Renaissance-era mathematician and astronomer who formulated a model of the universe that placed the Sun rather than the Earth at the center of the universe

Sir Isaac Newton

An English mathematician, astronomer, theologian, author and physicist Newton formulated the laws of motion and universal gravitation

Daniel Gabriel Fahrenheit

A Dutch-German-Polish physicist, inventor, and scientific instrument maker. A pioneer of exact thermometry, he helped lay the foundations for the era of precision thermometry by inventing the mercury-in-glass thermometer (first practical, accurate thermometer) and Fahrenheit scale

Anders Celsius

A Swedish astronomer who is known for inventing the Celsius temperature scale. Celsius also built the

Uppsala Astronomical Observatory in 1740, the oldest astronomical observatory in Sweden.

Michael Faraday

A British scientist who contributed to the study of electromagnetism and electrochemistry. His main discoveries include the principles underlying electromagnetic induction, diamagnetism and electrolysis.

William Thomson

Also known as Lord Kelvin was an eminent physicist, mathematician, engineer and inventor. He is best known for his contributions to physics in the development of the second law of thermodynamics, the electromagnetic theory of light and the absolute temperature scale, which is measured in kelvins in his honor.

Joseph Henry

An American scientist who served as the first Secretary of the Smithsonian Institution. He was the secretary for the National Institute for the Promotion of Science, a precursor of the Smithsonian Institution. He was highly regarded during his lifetime. While building electromagnets, Henry discovered the electromagnetic phenomenon of self-inductance.

James Prescott Joule

A studied the nature of heat and established its relationship to mechanical work. He laid the foundation for the theory of conservation of energy, which later influenced the First Law of Thermodynamics. He also formulated the Joule’s law which deals with the transfer of energy.

Samuel Morse

A polymath who studied mathematics and science at college supporting himself selling the works of art he painted. He became a renowned artist and took part in the invention of the telegraph.

Hans Christian Oersted

He discovered that electricity and magnetism are linked. He showed by experiment that an electric current flowing through a wire could move a nearby magnet. The discovery of electromagnetism set the stage for the eventual development of our modern technology-based world. Oersted also discovered the chemical compound piperine and achieved the first isolation of the element aluminum.

Georg Simon Ohm

A German physicist, best known for his “Ohm’s Law”, which states that the current flow through a conductor is directly proportional to the potential difference (voltage) and inversely proportional to the resistance. The physical unit of electrical resistance, the Ohm (symbol: Ω), was named after him.

James Watt

The father of the industrial revolution; an inventor, engineer and scientist. His crucial role in transforming our world from one based on agriculture to one based on engineering and technology is recognized in the unit of power: the watt.

Alessandro Volta

An Italian physicist, chemist, and a pioneer of electricity and power,[2][3][4] who is credited as the inventor of the electrical battery and the discoverer of methane.

Ada Lovelace

A pioneer of computing science. She took part in writing the first published program and was a computing visionary, recognizing for the first time that computers could do much more than just calculations.

Resources

Scientific Inquiry

MS-PS2-1 (5.2.8.A.3)	Investigating Magnetic Fields
MS-PS2-2 (5.2.6.E.3)	Investigating the Effects of Mass on the Speed of a Rolling Object.
MS-PS3-1 (5.2.8.E.1)	Investigating Heat Transfer
MS-PS3-5 (5.2.8.E.2)	Energy Transfer in Motion