Unit 8-2 Sound Waves

Content Area: **Science**
Course(s): **Science 8**
Time Period: **MP1-2**
Length: **MP1-2**
Status: **Published**

Essential Questions

- How do you describe the motion of an object?
- How do objects react to force?
- How is energy conserved in a transformation?
- How does heat flow from one object to another?
- How are electricity and magnetism related?

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.

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.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions

- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
- Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). (MS-PS2-5)

PS3.A: Definitions of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)

- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

PS3.C: Relationship between Energy and Forces

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

Science and Engineering Practices

Energy

Developing and Using Models

- Develop a model to describe unobservable mechanisms. (MS-PS3-2)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)

Analyzing and Interpreting Data

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

Engaging in Argument from Evidence

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Forces and Interactions

Asking Questions and Defining Problems

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be

recorded, and how many data are needed to support a claim. (MS-PS2-2)
- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

Engaging in Argument from Evidence

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

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.

Enduring Understandings

MS. Motion and Stability: Forces and Interactions

MS.PS2-1 Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.

MS.PS2-2 Plan an investigation to 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.

MS.PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS.PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS.PS2-5 Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

MS. Energy

MS.PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS.PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MS.PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS.PS3-4 Plan and investigation to determine the relationship among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS.PS3-5 Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Focus Areas

Motion

- An object is in motion if it changes position relative to a reference point
- To calculate the speed of an object, divide the distance the object travels by the amount of time it takes to travel the distance.
- When you know both the speed and direction of an object's motion you know the velocity of the object.
- You can show the motion of an object on a line graph in which you plot distance versus time.
- In science, acceleration refers to increasing speed, decreasing speed, or changing direction.
- You can use both a speed-versus-time graph and a distance-versus-time graph to analyze the motion of an accelerating object.

Forces

- Like velocity and acceleration, a force is described by its strength and by the direction in which it acts.
- A nonzero net force causes a change in an object's motion.
- Two factors that affect the force of friction are the types of surfaces involved and how hard the surfaces are pushed together.
- Two factors affect the gravitational attraction between objects; their masses and distance.
- Objects at rest will remain at rest and objects moving at a constant velocity will continue moving at a constant velocity unless they are acted upon by non-zero net forces.
- The acceleration of an object depends on its mass and on the net force acting on it.
- If one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object.
- The momentum of a moving object can be determined by multiplying the object's mass by its velocity.
- The total momentum of any group of objects remains the same, or is conserved, unless outside forces act on the objects.

- Free fall is motion where the acceleration is caused by gravity.
- Satellites in orbit around Earth continuously fall toward Earth, but because Earth is curved the travel around it.

Energy

- Since the transfer of energy is work, then power is the rate at which energy is transferred, or the amount of energy transferred in a unit of time.
- The two basic types of energy are kinetic energy and potential energy.
- You can find an object's mechanical energy by adding together the object's kinetic energy and potential energy.
- Forms of energy associated with the particles of objects include nuclear energy, thermal energy, electrical energy, electromagnetic energy, and chemical energy.
- All forms of energy can be transformed into other forms of energy.
- According to the law of conservation of energy, energy cannot be created or destroyed.

Magnetism and Electromagnetism

- Magnets attract iron and materials that contain iron. Magnets attract or repel other magnets. In addition, one end of a magnet will always point north when allowed to swing freely.
- Magnetic poles that are unlike attract each other, and magnetic poles that are alike repel each other.
- Magnetic field lines spread out from one pole, curve around the magnet and return to the other pole.
- Like a bar magnet, Earth has a magnetic field around it and two magnetic poles.
- An electric current produces a magnetic field.
- The magnetic field produced by a current can be turned on or off, reverse direction or change its strength.
- Both solenoids and electromagnets use electric currents and coiled wired to produce strong magnetic fields.
- By placing a wire with a current in a strong magnetic field, electric energy can be transformed into mechanical energy.
- An electric current turns the pointer of a galvanometer.
- An electric motor transforms electrical energy into mechanical energy.
- An electric current is induced in a conductor when the conductor moves through a magnetic field.
- A generator uses motion in a magnetic field to produce current.
- A transformer is a device that increases or decreases voltage.

Cross Cutting 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:

*See Appendix E for Cross Content

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