Unit 8: Waves, Sound and Light

Content Area: **Science**
Course(s):
Time Period: **Marking Period 4**
Length: **4 Weeks**
Status: **Published**

Summary

This unit will investigate the propagation of waves in various media. We will examine the relationship between frequency, wavelength, and speed of waves, and how these qualities are affected by the medium of the wave. Differences between light waves and sound waves will be discussed. We will also examine how earthquakes relate to wave motion and what they reveal about the Earth's structure.

Revised: July 2026

1	Make sense of problems and persevere in solving them
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
L.SS.11–12.1.A	Apply the understanding that usage is a matter of convention, can change over time, and place, and is sometimes contested.
2	Reason abstractly and quantitatively
3	Construct viable arguments and critique the reasoning of others
4	Model with mathematics
L.KL.11–12.2.A	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level.
5	Use appropriate tools strategically
L.KL.11–12.2.C	Demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
6	Attend to precision
L.VL.11–12.3.D	Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.
RI.CR.11–12.1	Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.
RI.CI.11–12.2	Determine two or more central ideas of an informational text and analyze how they are developed and refined over the course of a text, including how they interact and build on one another to provide a complex account or analysis; provide an objective summary of the text.
RI.MF.11–12.6	Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).
W.AW.11–12.1.A	Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

W.AW.11–12.1.D	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
W.AW.11–12.1.E	Provide a concluding paragraph or section that supports the argument presented (e.g., articulating implications or the significance of the topic).
SL.PE.11–12.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.PE.11–12.1.B	Collaborate with peers to promote civil, democratic discussions and decision-making, set clear goals and assessments (e.g., student developed rubrics), and establish individual roles as needed.
SL.II.11–12.2	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
HS-PS4	Waves and Their Applications in Technologies for Information Transfer
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
	Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the earth.
	Assessment is limited to algebraic relationships and describing those relationships qualitatively.
	Using Mathematics and Computational Thinking
	Mathematical and computational thinking at 9–12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
PS4.A	Wave Properties
	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.
	Cause and Effect
	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
	Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.
	Asking Questions and Defining Problems
	Asking questions and defining problems in grades 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

PS4.A	Wave Properties
	Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.
	Stability and Change
	Systems can be designed for greater or lesser stability.
HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
	Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.
	Assessment does not include using quantum theory.
	Engaging in Argument from Evidence
	Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.
	Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
PS4.A	Wave Properties
	Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.
	(Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.)
PS4.B	Electromagnetic Radiation
	Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
	Systems and System Models
	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
HS-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.
	Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.
PS4.B	Electromagnetic Radiation
	When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.
	Cause and Effect

	Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology. Assessments are limited to qualitative information. Assessments do not include band theory. Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.
PS4.A	Wave Properties Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.
PS4.B	Electromagnetic Radiation Photoelectric materials emit electrons when they absorb light of a high-enough frequency.
PS4.C	Information Technologies and Instrumentation Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

Essential Questions/Enduring Understandings

How are waves of different kinds relevant to our everyday lives?

How can learning about ocean waves help us understand the most high-tech and modern communications devices?

How can knowledge of waves help keep humans safe?

Sound waves can move through many different media, and they can be detected in different ways and by different organisms.

Electromagnetic waves influence every aspect of modern day life, from cooking, to communication, to the environment.

Objectives

Students will know the characteristics and properties of waves.
Students will be skilled at calculations involving the speed of a wave.
Students will know the difference between a transverse and a longitudinal wave.
Students will be skilled at predicting wave inteference patterns.
Students will know what a standing wave is and how to identify its features.
Students will know what the Doppler Effect is and how to predict the frequency an observer will hear when an source of sound waves is moving.
Students will know what the electromagnetic spectrum is and the common practical applications of each type of electromagnetic radiation.
Students will know how we see and how light travels.
Students will use the ISLE cycle to test different models of how light is emitted from a luminous object.

Learning Plan

Students will investigate waves using equipment in class and PhET simulations to define and identify the parts of a wave.

Transverse and longitudinal waves are generated and compared.

Students will complete an investigative lab about standing waves using equipment. Practice and group problem solving on waves, standing waves, doppler effect, resonance, and other phenomena.

Students will use the ISLE cycle to replicate observations first made by Al Hazen in the ancient Islamic world, and they will use those observations to determine how light travels and how our eyes detect light. Prior knowledge from biology, psychology, and anatomy and physiology will be incorporated depending on students' prior coursework.

At the end of the unit, students will use equipment and internet resources to learn about the electromagnetic spectrum and its many practical applications.

Assessment

Formative: Students will work together in small groups to draw waves and wave interference patterns on whiteboards which will be presented to the class. Students will also work in small groups to solve problems using wave diagrams, mathematical models, and drawings. This will provide an opportunity for student critique and teacher feedback. Students will complete independent homework assignments that will be reviewed in class so that students can self-assess.

Summative: Quizzes on Waves and Sound, Unit Test Labs: Speed of Sound lab, Project: Making Waves with the Electromagnetic Spectrum project, and/or Musical Instrument poster.

Benchmark: This unit is included in the final exam.

Alternative: Presentation of Electromagnetic Spectrum or Speed of Sound

Materials

Computer with PowerPoint/Google Slides and internet access

Textbook Physics: Principles and Problems, Glencoe

Calculators, rulers, meter sticks, colored pencils, graph paper, Chromebooks for students, whiteboards for collaborative work, dry erase markers and erasers for student groups, springs, chalk, working window shades, prisms, lasers.

Integrated Accommodations and Modifications

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education, and those with 504s

https://docs.google.com/spreadsheets/d/18XhAi7Rm-E8LJwO4uMQS7ZEh0dh3NxYbTFH2IoHLH7Y/edit?usp=sharing