Unit 8: Waves and Sound

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. We will also examine how earthquakes relate to wave motion and what they reveal about the Earth's structure.

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CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
LA.RST.9-10	Reading Science and Technical Subjects
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
LA.RST.9-10.4	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 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
LA.RST.9-10.6	Determine the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
LA.RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
LA.RST.9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
LA.RST.9-10.10	By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.
LA.WHST.9-10	Writing History, Science and Technical Subjects
LA.WHST.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant sufficient textual and non-textual evidence.
LA.WHST.9-10.1.A	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s),

	counterclaims, reasons, and evidence.
LA.WHST.9-10.1.B	Develop claim(s) and counterclaims using sound reasoning, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
LA.WHST.9-10.1.C	Use transitions (e.g., words, phrases, clauses) to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
LA.WHST.9-10.1.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.
LA.WHST.9-10.1.E	Provide a concluding paragraph or section that supports the argument presented.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.9-10.2.A	Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
LA.WHST.9-10.2.B	Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
LA.WHST.9-10.2.C	Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
LA.WHST.9-10.2.D	Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
LA.WHST.9-10.2.E	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.
LA.WHST.9-10.2.F	Provide a concluding paragraph or section that supports the argument presented.
LA.WHST.9-10.3	(See note; not applicable as a separate requirement)
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.
SCI.HS.PS4.A	Wave Properties
SCI.HS.PS4.A	Wave Properties
SCI.HS.PS4.A	Wave Properties
SCI.HS.PS4.A	Wave Properties
SCI.HS.PS4.B	Electromagnetic Radiation
SCI.HS.PS4.B	Electromagnetic Radiation
SCI.HS.PS4.B	Electromagnetic Radiation

SCI.HS.PS4.C	Information Technologies and Instrumentation
SCI.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.
SCI.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.
SCI.HS-PS4	Waves and Their Applications in Technologies for Information Transfer
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
SCI.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.
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
	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.
	Using Mathematics and Computational Thinking
	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.
	Craft and Structure
	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.
	Obtaining, Evaluating, and Communicating Information
	Assessment does not include using quantum theory.
	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
	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.
	Stability and Change
	Cause and Effect
	Range of Reading and Level of Text Complexity
	Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.
	Assessments are limited to qualitative information. Assessments do not include band theory.
	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.

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.

Text Types and Purposes

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.

Systems and System Models

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).

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Asking Questions and Defining Problems

Integration of Knowledge and Ideas

Engaging in Argument from Evidence

Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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.

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.

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.

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.

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.

Cause and Effect

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.

Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

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.

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.

Systems can be designed for greater or lesser stability.

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.

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.

Key Ideas and Details

(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.)

Photoelectric materials emit electrons when they absorb light of a high-enough frequency.

Assessment is limited to algebraic relationships and describing those relationships qualitatively.

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 resonance is and how to calculate beat frequencies.
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.

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.

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, Lab: Hooke's Law lab, 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, tuning forks, pipes and buckets for speed for speed of sound lab, access to water, prisms, laser.

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