



## Unit 4: Waves: Waves and Information

**9 weeks**

In this unit, students will explore waves, wave properties, and how they help us transfer information. Students will learn about the characteristic properties of waves, such as amplitude, wavelength, and frequency, and that waves are repeating patterns of motion that transfer energy. Amplitude is the size or height of the wave and is associated with volume of sound. Wavelength is the distance or spacing between wave peaks. Frequency is the number of waves produced during a given amount of time. Students will develop a model of waves that will describe patterns in terms of these properties.

Students will also understand that information can be digitized in order to transmit/transfer information across long distances. Students will learn about how high-tech devices, such as computers or cell phones, receive and decode information and then convert the information, making it visible or able for us to use. Students will compare analog and digital signals and will be able to explain basic processes for transmitting signals in a variety of ways. They will generate and compare multiple solutions that use patterns to transfer information, such as using Morse code, binary code, or other such code patterns. Students will then design, test and modify a system for transmitting information.

### Unit 4 Performance Expectations

- ❖ **4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.**  
*Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.*  
*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*
  
- ❖ **4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.\***  
*Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1s and 0s representing black and white to send information about a picture, or using Morse code to send text.*
  
- ❖ **4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** (this standard was initiated in previous unit on Energy)  
*Assessment Boundary: Assessment does not include quantitative measurements of energy.*

### Unit 4 Essential Questions:

- ❖ What are waves?
- ❖ How are waves used to transfer energy and information?
- ❖ How are instruments that transmit and detect waves used to extend the human senses?



**In Unit 4, students will understand...**

- ❖ Waves are regular patterns of motion, a disturbance that moves or spreads throughout space.
- ❖ Waves can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place.
- ❖ Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between the wave peaks).
- ❖ Waves of different amplitudes transfer different amounts of energy.
- ❖ Patterns can be used to communicate information across a distance.
- ❖ Information can be digitized and transmitted.
- ❖ High-tech devices, such as computers or cell phones, can receive and decode information – convert it from digitized for to voice – and vice versa.
- ❖ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and constraints.

**Foundational Knowledge:**

Prior to 4<sup>th</sup> grade, students should have knowledge, understanding of, and experiences with the following ideas:

- ❖ Waves in water spread out in circles. The surface of the water moves up and down while a wave spreads outward.
- ❖ Sound can make matter vibrate, and vibrating matter can make sound.
- ❖ Objects can be seen if light is available to illuminate them or if they give off their own light.
- ❖ Light travels from place to place.
- ❖ Some materials allow light to pass through them; others allow only some light through.
- ❖ Some materials block all the light and create a dark shadow on any surface beyond them, where light cannot reach.
- ❖ Mirrors can be used to redirect a light beam.
- ❖ People use a variety of devices to communicate (send/receive information) over long distances.
- ❖ People can detect light with their eyes, sound with their ears, and vibrations with their fingertips.

*With the implementation of new standards, students may not have had opportunities to engage in these foundational understandings and ideas before 4<sup>th</sup> grade. You may need to provide opportunities for students to experience these ideas as you move forward.*

**Unit Vocabulary:**

sound  
vibration  
light  
wave(s)  
energy

parallel  
perpendicular  
trough  
peak/crest  
medium  
transfer

amplitude  
wavelength  
frequency  
longitudinal  
transverse  
transmit/receive

communication  
pattern  
digital  
Morse code  
binary code  
decode/encode



**Additional Content Connections:**

\*These connections provide opportunities to score to other content standards with focused instruction.

**ELA:**

## ❖ Speaking and Listening

- SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.
- SL.4.2 Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

## ❖ Writing

- W.4.1 Write opinion pieces on topics or texts supporting the opinion with reasons.
- W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources: take notes and categorize information; provide a list of sources.
- W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

**Mathematics:**

## ❖ Draw and identify lines and angles

- 4.G.A.1 Draw points, lines, line segments, rays, angles, and perpendicular and parallel lines; identify these in two-dimensional figures
- 4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts; identify line-symmetric figures and draw lines of symmetry



**Waves: Waves and Information**

Students who demonstrate understanding can:

**4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

**4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.\*** [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1s and 0s representing black and white to send information about a picture, or using Morse code to send text.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><b>Developing and Using Models</b> Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</p> <ul style="list-style-type: none"> <li>Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)</li> </ul> <p><b>Constructing Explanations and Designing Solutions</b> Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</p> <ul style="list-style-type: none"> <li>Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)</li> </ul> <p>-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science findings are based on recognizing patterns. (4-PS4-1)</li> </ul>	<p><b>PS4.A: Wave Properties</b></p> <ul style="list-style-type: none"> <li>Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (4-PS4-1)</li> <li>Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)</li> </ul> <p><b>PS4.C: Information Technologies and Instrumentation</b></p> <ul style="list-style-type: none"> <li>Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)</li> </ul> <p><b>ETS1.C: Optimizing The Design Solution</b></p> <ul style="list-style-type: none"> <li>Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (4-PS4-3)</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1)</li> <li>Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3)</li> </ul> <p>-----</p> <p style="text-align: center;"><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)</li> </ul>

