FOURTH GRADE: WAVES

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon potential for related phenomena that can be used throughout a unit.

4-PS3-2 Make observations to provide evidence for how energy can be transferred from place to place by sound, light, heat, and electric currents. (SEP: 3; DCI: PS3.A, PS3.B; CCC: Energy/Matter) *[Assessment Boundary: Assessment does not include quantitative measurements of energy.]*

4-PS3-4 Design, test, and refine a device that converts energy from one form to another. (SEP: 6; DCI: PS3.B, PS3.D, ETS1.A ; CCC: Energy/Matter) [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] *[Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]*

4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and to provide evidence that waves can cause objects to move. (SEP: 2 ; DCI: PS4.A; CCC: Patterns) [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.]*

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

Energy can be observed in a variety of situations. By observing motion of objects, transfer of sound, light, heat, electric currents, and motion of waves, we can see that energy is transferred and can be converted from one form to another. Through observations of waves we see patterns in wave amplitude and wavelength.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- Observe a slinky.
- Seismic waves during an earthquake.
- Water in puddles ripple when a car drives by.
- Observe a boat or canoe riding on the waves gets to the shore without a motor or paddle.
- Observe how a guitar makes sound/music.

Storyline

This section aims to decode not only the DCI connections, but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations ● Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. **Developing and Using Models** ● Develop a model using an analogy, example, or abstract representation to describe a scientific principle **Constructing Explanations and Designing Solutions**	**PS3.A: Definitions of Energy** ● Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and Energy Transfer** ● Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. ● Light also transfers energy from place to place. ● Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or	**Energy and Matter** ● Energy can be transferred in various ways and between objects. **Patterns** ● Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for

● Use evidence (e.g., measurements, observations, patterns) to construct an explanation.	light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. **PS3.D: Energy in Chemical Processes and Everyday Life** ● The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. **PS4.A: Wave Properties** ● 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. (Note: This grade band endpoint was moved from K–2.) ● Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). **ETS1.A: Defining Engineering Problems** ● Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.(secondary)	natural phenomena.

Energy can be observed all around us. Energy is present and can be observed through moving objects and through observing how sound, light, and heat are transmitted.

Students can make observations, plan and carry out investigations on phenomena that allows them to see that energy exists and it is transferred within a system. For example, colliding objects and objects that produce sound in order to determine a pattern that vibrations accompany sound, light, heat, and electrical currents.

Students can explain using models that energy can be transferred between objects. If given the opportunity to explore energy in a variety of situations (motion, sound, light, heat, electrical currents), students can explain how energy exists in each of those situations. Students can make connections among the situations and identify a pattern, that energy is transferred in each of those situations.

Students can observe that the transfer of energy between objects involves waves, which have measurable features, such as amplitude and wavelength. Students can observe and measure how waves move objects up and down or forward and backward. Students can analyze the movement of waves and make a model of a wave. Through this model, students will see the patterns in amplitude and wavelengths of waves.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard or lesson-level performance expectation.

Resources to inform your formative assessment.

http://stemteachingtools.org/brief/30
http://stemteachingtools.org/brief/41
http://stemteachingtools.org/pd/sessionb

SEP Developing and Using Models

- Create a model out of wire showing the different parts of a wave. (Could use other materials as well to show different parts of a wave.)
- Draw a model based on a given amplitude and wavelength.

SEP Planning and Carrying Out Investigations

- Build a solar oven and record data to show how heat was captured.

CCC Energy and Matter

- Build an electric circuit and explain how energy is transferred.
- Refine the design of something that converts energy from one form to another.

CCC Patterns

- Use a diagram to show the patterns of a wave.
- Explain patterns found within a variety of given waves.

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain-size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Develop a model** to *show the patterns* of waves and how energy is transferred.
- **Plan and carry out an investigation** to *determine the best way* to capture heat in a solar oven.
- **Create a model** to explain *transfer of energy* using at least two or more of sound, light, heat, or electrical currents.