

DRAFT - New York State P-12 Science Learning Standards – DRAFT

4. Energy

Students who demonstrate understanding can:

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.** [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]
- 4-PS3-2. Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another.** [Clarification Statement: Examples of forms of energy could include sound, light, heat, and electrical.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]
- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.** [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]
- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into energy of motion of a vehicle, light, or sound; batteries that convert chemical energy to electrical energy; 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-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.** [Clarification Statement: Examples of renewable energy resources could include wind, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

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>Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.</p> <ul style="list-style-type: none"> ▪ Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) <p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> ▪ Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2) <p>Constructing Explanations and Designing Solutions 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"> ▪ Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) ▪ Apply scientific ideas to solve design problems. (4-PS3-4) <p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.</p> <ul style="list-style-type: none"> ▪ Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1) 	<p>PS3.A: Definitions of Energy</p> <ul style="list-style-type: none"> ▪ (NYSEd) A given object possesses more energy of motion when it is moving faster. (4-PS3-1) ▪ (NYSEd) Energy can be transferred by moving objects or by sound, light, heat, or electric currents. (4-PS3-2), (4-PS3-3) <p>PS3.B: Conservation of Energy and Energy Transfer</p> <ul style="list-style-type: none"> ▪ 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. (4-PS3-2), (4-PS3-3) ▪ (NYSEd) Energy can also be transferred by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4) <p>PS3.C: Relationship Between Energy and Forces</p> <ul style="list-style-type: none"> ▪ When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) <p>PS3.D: Energy in Chemical Processes and Everyday Life</p> <ul style="list-style-type: none"> ▪ The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> ▪ Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1) <p>ETS1.A: Defining Engineering Problems</p> <ul style="list-style-type: none"> ▪ 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. (<i>secondary to 4-PS3-4</i>) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> ▪ Cause and effect relationships are routinely identified and used to explain change. (4-ESS3-1) <p>Energy and Matter</p> <ul style="list-style-type: none"> ▪ Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4) <p>-----</p> <p style="text-align: center;"><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>-----</p> <p>Interdependence of Science, Engineering, and Technology</p> <ul style="list-style-type: none"> ▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (4-ESS3-1) <p>Influence of Engineering, Technology, and Science on Society and the Natural World</p> <ul style="list-style-type: none"> ▪ Over time, people's needs and wants change, as do their demands for new and improved technologies. (4-ESS3-1) ▪ Engineers improve existing technologies or develop new ones. (4-PS3-4) <p>-----</p> <p style="text-align: center;"><i>Connections to Nature of Science</i></p> <p>-----</p> <p>Science is a Human Endeavor</p> <ul style="list-style-type: none"> ▪ Most scientists and engineers work in teams. (4-PS3-4) ▪ Science affects everyday life. (4-PS3-4)

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels: K.PS2.B (4-PS3-3); K.ETS1.A (4-PS3-4); 2.ETS1.B (4-PS3-4); 3.PS2.A (4-PS3-3); 5.PS3.D (4-PS3-4); 5.LS1.C (4-PS3-4); 5.ESS3.C (4-ESS3-1); MS.PS2.A (4-PS3-3); MS.PS2.B (4-PS3-2); MS.PS3.A (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4); MS.PS3.B (4-PS3-2), (4-PS3-3), (4-PS3-4); MS.PS3.C (4-PS3-3); MS.PS3.D (4-ESS3-1); MS.PS4.B (4-PS3-2); MS.ESS2.A (4-ESS3-1); MS.ESS3.A (4-ESS3-1); MS.ESS3.C (4-ESS3-1); MS.ESS3.D (4-ESS3-1); MS.ETS1.B (4-PS3-4); MS.ETS1.C (4-PS3-4)

Common Core State Standards Connections:

ELA/Literacy –

- RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1)
- RI.4.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4-PS3-1)
- RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)
- W.4.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1)
- W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2), (4-PS3-3), (4-PS3-4), (4-ESS3-1)
- W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4), (4-ESS3-1)
- W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1), (4-ESS3-1)

Mathematics –

- MP.2** Reason abstractly and quantitatively. (4-ESS3-1)
- MP.4** Model with mathematics. (4-ESS3-1)
- 4.OA.A.1** Interpret a multiplication equation as a comparison, e.g., interpret $35 = 5 \times 7$ as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1)
- 4.OA.A.3** Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-4)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea. The text in the "Disciplinary Core Ideas" section is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas unless it is preceded by (NYSEd).

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4. 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 1's and 0's representing black and white to send information about a picture, and 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>Developing and Using Models 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"> ▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1) <p>Constructing Explanations and Designing Solutions 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"> ▪ 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) <p style="text-align: center;">----- <i>Connections to Nature of Science</i></p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> ▪ Science findings are based on recognizing patterns. (4-PS4-1) 	<p>PS4.A: Wave Properties</p> <ul style="list-style-type: none"> ▪ 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. (<i>Note: This grade band endpoint was moved from K–2.</i>) (4-PS4-1) ▪ Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1) <p>PS4.C: Information Technologies and Instrumentation</p> <ul style="list-style-type: none"> ▪ 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) <p>ETS1.C: Optimizing The Design Solution</p> <ul style="list-style-type: none"> ▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (<i>secondary to 4-PS4-3</i>) 	<p>Patterns</p> <ul style="list-style-type: none"> ▪ Similarities and differences in patterns can be used to sort and classify natural phenomena. (4-PS4-1) ▪ Similarities and differences in patterns can be used to sort and classify designed products. (4-PS4-3) <p style="text-align: center;">----- <i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>Interdependence of Science, Engineering, and Technology</p> <ul style="list-style-type: none"> ▪ Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

Connections to other DCIs in fourth grade: **4.PS3.A** (4-PS4-1); **4.PS3.B** (4-PS4-1); **4.ETS1.A** (4-PS4-3)

Articulation of DCIs across grade-levels: **K.ETS1.A** (4-PS4-3); **1.PS4.C** (4-PS4-3); **2.ETS1.B** (4-PS4-3); **2.ETS1.C** (4-PS4-3); **3.PS2.A** (4-PS4-3); **MS.PS4.A** (4-PS4-1); **MS.PS4.C** (4-PS4-3); **MS.ETS1.B** (4-PS4-3)

Common Core State Standards Connections:

ELA/Literacy –

- RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (*4-PS4-3*)
- RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS4-3)
- SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (*4-PS4-1*)

Mathematics –

- MP.4** Model with mathematics. (*4-PS4-1*)
- 4.G.A.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (*4-PS4-1*)

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