DCI Arrangements of the Next Generation Science Standards

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Elementary Standards

Students in kindergarten through fifth grade begin to develop an understanding of the four disciplinary core ideas: physical sciences; life sciences; earth and space sciences; and engineering, technology, and applications of science. In the earlier grades, students begin by recognizing patterns and formulating answers to questions about the world around them. By the end of fifth grade, students are able to demonstrate grade-appropriate proficiency in gathering, describing, and using information about the natural and designed world(s). The performance expectations in elementary school grade bands develop ideas and skills that will allow students to explain more complex phenomena in the four disciplines as they progress to middle school and high school. While the performance expectations shown in kindergarten through fifth grade couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.
Fourth Grade

The performance expectations in fourth grade help students formulate answers to questions such as: “What are waves and what are some things they can do? How can water, ice, wind and vegetation change the land? What patterns of Earth’s features can be determined with the use of maps? How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals? What is energy and how is it related to motion? How is energy transferred? How can energy be used to solve a problem?” Fourth grade performance expectations include PS3, PS4, LS1, ESS1, ESS2, ESS3, and ETS1 Disciplinary Core Ideas from the NRC Framework. Students are able to use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move. Students are expected to develop understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans. In order to describe patterns of Earth’s features, students analyze and interpret data from maps. Fourth graders are expected to develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye. Students are able to use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object. Students are expected to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electric currents or from object to object through collisions. They apply their understanding of energy to design, test, and refine a device that converts energy from one form to another. The crosscutting concepts of patterns; cause and effect; energy and matter; systems and system models; interdependence of science, engineering, and technology; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the fourth grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.
## 4-PS3 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 can be transferred from place to place by sound, light, heat, and electric currents.** [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 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.]

### Science and Engineering Practices

**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.
  - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3)

**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.
  - 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)

**Constructing Explanations and Designing Solutions**

- Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to use evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.
  - Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1)
  - Apply scientific ideas to solve design problems. (4-PS3-4)

**Engineering Practices**

- **Defining Engineering Problems**: The faster a given object is moving, the more energy it possesses. (4-PS3-1)
  - Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2, 4-PS3-3)

**Disciplinary Core Ideas**

**PS3.A: Definitions of Energy**

- *The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

**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. (4-PS3-2, 4-PS3-3)
  - Light also transfers energy from place to place. (4-PS3-2)
  - Energy can also be transferred from place to place 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)

**PS3.C: Relationship Between Energy and Forces**

- When objects collide, the contact forces transfer energy so as to change the objects’ motions. (4-PS3-3)

**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. (4-PS3-4)

**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 to 4-PS3-4)

### Crosscutting Concepts

**Energy and Matter**

- Energy can be transferred in various ways and between objects. (4-PS3-1, 4-PS3-2, 4-PS3-3, 4-PS3-4)

**Connections to Engineering, Technology, and Applications of Science**

- Engineers improve existing technologies or develop new ones. (4-PS3-4)

**Connections to Nature of Science**

- Science is a human endeavor.
  - Most scientists and engineers work in teams. (4-PS3-4)
  - Science affects everyday life. (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-PS3-3)
- **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)
- **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)
- **W.4.9**: Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1)

**Mathematics**

- **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 section entitled “Disciplinary Core Ideas” is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences. June 2013 ©2013 Achieve, Inc. All rights reserved.*
**4-PS4 Waves and their Applications in Technologies for Information Transfer**

**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-PS4.2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.  
[Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.]

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.]

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**Science and Engineering Practices**

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.

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle. (4-PS4-1)
- Develop a model to describe phenomena. (4-PS4-2)

**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.

- 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)

**Disciplinary Core Ideas**

**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.) (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)

**PS4.B: Electromagnetic Radiation**

- An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)

**PS4.C: Information Technologies and Instrumentation**

- 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)

**ETS1.C: Optimizing The Design Solution**

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (secondarily to 4-PS4-3)

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**Articulation of DCIs across grade levels:**

- K.ETS1.A (4-PS4-3); 1.PS4.B (4-PS4-2); 1.PS4.C (4-PS4-3); 2.EPS1.A (4-PS4-3); 2.EPS1.B (4-PS4-3); 2.EPS1.C (4-PS4-3); 3.PS2.A (4-PS4-3); MS.PS4.A (4-PS4-1); MS.PS4.B (4-PS4-2); MS.PS4.C (4-PS4-3); MS.LS1.D (4-PS4-2); MS.EPS1.B (4-PS4-3)

**Connections to other DCIs in fourth grade:**

- 4.PS3.A (4-PS4-1); 4.PS3.B (4-PS4-1); 4.EPS1.A (4-PS4-3)

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**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),(4-PS4-2)

**Mathematics**

- MP.4 Model with mathematics. (4-PS4-1),(4-PS4-2)
- 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),(4-PS4-2)

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4-LS1 From Molecules to Organisms: Structures and Processes

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<td><strong>LS1.A: Structure and Function</strong></td>
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| 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.  
  - Use a model to test interactions concerning the functioning of a natural system.  (4-LS1-2)  
| **Engaging in Argument from Evidence**  | **LS1.A: Structure and Function**  |
| Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).  
  - Construct an argument with evidence, data, and/or a model.  (4-LS1-1)  
| **Articulation of DCIs across grade levels:**  |  |
| 1.LS1.A  (4-LS1-1); 1.LS1.D  (4-LS1-2); 3.LS3.B  (4-LS1-1); MS.LS1.A  (4-LS1-1),(4-LS1-2); MS.LS1.D  (4-LS1-2)  |
| **Common Core State Standards Connections:**  |  |
| ELA/Literacy –  |
| W.4.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.  (4-LS1-1)  |
| SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.  (4-LS1-2)  |
| Mathematics –  |
| 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 across the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.  (4-LS1-1)  |
| **Connections to other DCIs in fourth grade:** N/A |

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4-ESS1 Earth’s Place in the Universe

**Science and Engineering Practices**

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**Disciplinary Core Ideas**

**ESS1.C: The History of Planet Earth**
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)

**Crosscutting Concepts**

- Patterns can be used as evidence to support an explanation. (4-ESS1-1)

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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**
  - Constructing Explanations and Designing Solutions
- **Disciplinary Core Ideas**
  - ESS1.C: The History of Planet Earth
- **Crosscutting Concepts**
  - Patterns

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4-ESS2 Earth’s Systems

Students who demonstrate understanding can:

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] (Assessment Boundary: Assessment is limited to a single form of weathering or erosion.)

4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth’s features. [Clarification Statement: Maps can include topographic maps of Earth’s land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

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