

## Accessing the ELA & CCSSM Connections in the NGSS

### SUMMARY

The Next Generation Science Standards (NGSS) cite connections to the national Common Core English/Language Arts (ELA) standards and Common Core State Standards in Mathematics (CCSSM). These connections provide ample opportunities for students to learn reading, writing, and math skills in the course of learning science concepts. Blending science, math, and language together makes learning fun and it better prepares students for the real-world.

### HOW TO DO IT?

1. Choose an NGSS grade-specific performance expectation (top of page).
2. Identify the Disciplinary Core Idea (DCI) required to achieve the expectation (middle column).
3. Choose a Common Core ELA standard from the connections box that identifies a task that would enhance or articulate the demonstration of the expectation (bottom of page).
4. Choose a Common Core Math standard from the connections box containing the math required to achieve the expectation.
5. Identify a science or engineering practice (left column) keyed to the expectation. This provides the scenario in which the performance expectation can be demonstrated. (NOTE: RAFT activity kits provide opportunities to teach and use the science and engineering practices in the NGSS and can be also used as tools to demonstrate understanding).

4-PS3 Energy		
<p><b>4-PS3 Energy</b></p> <p>Students who demonstrate understanding can:</p> <p><b>4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.</b> (Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or an analysis by quantitative definition of energy.)</p> <p><b>4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.</b> (Assessment Boundary: Assessment does not include quantitative measurements of energy.)</p> <p><b>4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.</b> (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.)</p> <p><b>4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*</b> (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.)</p> <p><small>The performance expectations above were developed using the following elements from the NGSS document: A Framework for K-12 Science Education.</small></p>		
<p><b>Science and Engineering Practices</b></p> <p><b>Asking Questions and Defining Problems</b></p> <p>Asking questions and defining problems is a key science and engineering practice. It involves asking questions and defining the problem to be solved. This practice is used to identify the problem, gather information, and define the problem in terms of a question that can be investigated.</p> <p><b>Planning and Carrying Out Investigations</b></p> <p>Planning and carrying out investigations involves developing a plan or model for an investigation, gathering data, and analyzing the data. This practice is used to design and conduct an investigation to test a hypothesis or answer a question.</p> <p><b>Constructing Explanations and Designing Solutions</b></p> <p>Constructing explanations and designing solutions involves developing an explanation or model for a phenomenon or designing a solution to a problem. This practice is used to analyze data, develop a model, and design a solution.</p>	<p><b>Disciplinary Core Ideas</b></p> <p><b>PS3.A: Definitions of Energy</b></p> <p>The faster a given object is moving, the more energy it possesses. (4-PS3-1)</p> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <p>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)</p> <p>Light also transfers energy from place to place. (4-PS3-2)</p> <p>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)</p> <p><b>PS3.C: Relationship Between Energy and Forces</b></p> <p>When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)</p> <p><b>PS3.D: Energy in Chemical Processes and Everyday Life</b></p> <p>The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)</p> <p><b>ETS1.A: Defining Engineering Problems</b></p> <p>Problem 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)</p>	<p><b>Crosscutting Concepts</b></p> <p><b>Energy and Matter</b></p> <p>Energy can be transferred in various ways and between objects. (4-PS3-1) (4-PS3-2) (4-PS3-3) (4-PS3-4)</p> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering and Technology on Society and the Natural World</b></p> <p>Engineers improve existing technologies or develop new ones. (4-PS3-4)</p> <p><b>Connections to Nature of Science</b></p> <p><b>Science is a Human Endeavor</b></p> <p>Most scientists and engineers work in teams. (4-PS3-4)</p> <p>Science affects everyday life. (4-PS3-4)</p>
<p><b>Connections to ELA and Math Standards:</b></p> <p>Connections to ELA Standards: RI.4.9, W.4.7, W.4.8, W.4.9, W.4.10, W.4.11, W.4.12, W.4.13, W.4.14, W.4.15, W.4.16, W.4.17, W.4.18, W.4.19, W.4.20, W.4.21, W.4.22, W.4.23, W.4.24, W.4.25, W.4.26, W.4.27, W.4.28, W.4.29, W.4.30, W.4.31, W.4.32, W.4.33, W.4.34, W.4.35, W.4.36, W.4.37, W.4.38, W.4.39, W.4.40, W.4.41, W.4.42, W.4.43, W.4.44, W.4.45, W.4.46, W.4.47, W.4.48, W.4.49, W.4.50, W.4.51, W.4.52, W.4.53, W.4.54, W.4.55, W.4.56, W.4.57, W.4.58, W.4.59, W.4.60, W.4.61, W.4.62, W.4.63, W.4.64, W.4.65, W.4.66, W.4.67, W.4.68, W.4.69, W.4.70, W.4.71, W.4.72, W.4.73, W.4.74, W.4.75, W.4.76, W.4.77, W.4.78, W.4.79, W.4.80, W.4.81, W.4.82, W.4.83, W.4.84, W.4.85, W.4.86, W.4.87, W.4.88, W.4.89, W.4.90, W.4.91, W.4.92, W.4.93, W.4.94, W.4.95, W.4.96, W.4.97, W.4.98, W.4.99, W.4.100.</p> <p>Connections to Math Standards: 4.OA.A.3, 4.OA.A.4, 4.OA.A.5, 4.OA.A.6, 4.OA.A.7, 4.OA.A.8, 4.OA.A.9, 4.OA.A.10, 4.OA.A.11, 4.OA.A.12, 4.OA.A.13, 4.OA.A.14, 4.OA.A.15, 4.OA.A.16, 4.OA.A.17, 4.OA.A.18, 4.OA.A.19, 4.OA.A.20, 4.OA.A.21, 4.OA.A.22, 4.OA.A.23, 4.OA.A.24, 4.OA.A.25, 4.OA.A.26, 4.OA.A.27, 4.OA.A.28, 4.OA.A.29, 4.OA.A.30, 4.OA.A.31, 4.OA.A.32, 4.OA.A.33, 4.OA.A.34, 4.OA.A.35, 4.OA.A.36, 4.OA.A.37, 4.OA.A.38, 4.OA.A.39, 4.OA.A.40, 4.OA.A.41, 4.OA.A.42, 4.OA.A.43, 4.OA.A.44, 4.OA.A.45, 4.OA.A.46, 4.OA.A.47, 4.OA.A.48, 4.OA.A.49, 4.OA.A.50, 4.OA.A.51, 4.OA.A.52, 4.OA.A.53, 4.OA.A.54, 4.OA.A.55, 4.OA.A.56, 4.OA.A.57, 4.OA.A.58, 4.OA.A.59, 4.OA.A.60, 4.OA.A.61, 4.OA.A.62, 4.OA.A.63, 4.OA.A.64, 4.OA.A.65, 4.OA.A.66, 4.OA.A.67, 4.OA.A.68, 4.OA.A.69, 4.OA.A.70, 4.OA.A.71, 4.OA.A.72, 4.OA.A.73, 4.OA.A.74, 4.OA.A.75, 4.OA.A.76, 4.OA.A.77, 4.OA.A.78, 4.OA.A.79, 4.OA.A.80, 4.OA.A.81, 4.OA.A.82, 4.OA.A.83, 4.OA.A.84, 4.OA.A.85, 4.OA.A.86, 4.OA.A.87, 4.OA.A.88, 4.OA.A.89, 4.OA.A.90, 4.OA.A.91, 4.OA.A.92, 4.OA.A.93, 4.OA.A.94, 4.OA.A.95, 4.OA.A.96, 4.OA.A.97, 4.OA.A.98, 4.OA.A.99, 4.OA.A.100.</p>		

### EXAMPLE OF THE PROCEDURE FOR NGSS 4<sup>TH</sup> GRADE ENERGY

1. **Performance expectation, 4-PS3-1:** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
2. **DCI PS3.A: Definitions of Energy:** The faster a given object is moving, the more energy it possesses.
3. **Common Core Connection, ELA, RI.4.9:** Integrate information from two science texts describing speed and energy in order to write or speak about the subject knowledgeably.
4. **Common Core Connection, Math, 4.OA.A.3:** Solve multi-step problems using whole numbers and equations with a letter variable for the unknown quantity.
5. **Science/Engineering Practice:** Constructing explanations and designing solutions; use evidence (e.g. measurements, observations, or patterns) to construct an explanation.

## APPLICATION

The 4<sup>th</sup> grade performance expectation above refers to an explanation involving non-quantitative descriptions of speed and energy, meaning students are not directly measuring or calculating the two quantities. For example, the students might do an activity where they repeatedly roll a ball down a ramp, increasing its speed each time by pushing it harder down the ramp and then observing how far it pushes a wooden block from the end of the ramp. They are not measuring the speed but can identify a pattern between the ball's relative speed and the movement of the block, measured in centimeters.

To incorporate the **ELA standard**, the teacher can provide two texts that have simple grade-level-appropriate descriptions, diagrams, and examples of energy transfer between objects. The students will integrate the texts and be able to describe the movement of the block in terms of energy transferred from the ball to the block. This description can be combined with the pattern already identified between the ball's speed and the block's movement to describe the pattern in terms of the ball's energy, thus providing students with enough information to understand that the faster a given object is moving, the more energy it possesses (DCI).

The connected **math standard** can be addressed if students are introduced to the kinetic energy equation  $KE = \frac{1}{2} mv^2$  conceptually, understanding that  $v^2$  is actually  $v \times v$ , that is, the variable  $v$  times itself (explained in terms of multiples, not exponents). This can aid students in articulating their explanation of why the ball had more energy with each stronger push (resulting in increased relative speed), which they observed as the block being pushed further from the ramp.

## ASSESSMENT

When designing activities that incorporate the science and engineering practices in the Next Generation Science Standards it is important to note the assessment boundaries listed for each performance expectation. For example, in the expectation discussed above the assessment boundary says, "Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy", meaning that in the example above the students will not make measuring the speed of the ball part of their explanation.

## RELATED RESOURCES

Some RAFT hands-on activities that can easily be used to teach the NGSS Science & Engineering Practices for grades K-12:

<b><i>Car on a Roll</i></b> -	<a href="http://www.raft.net/ideas/Car on a Roll.pdf">http://www.raft.net/ideas/Car on a Roll.pdf</a>
<b><i>Colors of Light</i></b> -	<a href="http://www.raft.net/ideas/Colors of Light.pdf">http://www.raft.net/ideas/Colors of Light.pdf</a>
<b><i>Critter Capsule</i></b>	<a href="http://www.raft.net/ideas/Critter Capsule.pdf">http://www.raft.net/ideas/Critter Capsule.pdf</a>
<b><i>Puff Rockets</i></b> -	<a href="http://www.raft.net/ideas/Puff Rocket.pdf">http://www.raft.net/ideas/Puff Rocket.pdf</a>

## OTHER RESOURCES

**Next Generation Science Standards –**  
<http://www.nextgenscience.org/next-generation-science-standards>

**Common Core Standards ELA/Literacy -**  
[http://www.corestandards.org/assets/CCSSI\\_ELA%20Standards.pdf](http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf)

**Common Core State Standards in Math -**  
[http://www.corestandards.org/assets/CCSSI\\_Math%20Standards.pdf](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf)