Grade 4 Example  **NGSS Topic:**  4. Energy

**Step 1- What performance expectations are related and can be included in instruction within the lessons/unit? (Cluster PEs)**
Choice was Grade 4 Performance Expectations in 4.Energy. These are bundled under the Topic view of the Standards at NextGenScience.org.

4-PS3-1  
4-PS3-3  
4-PS3-4

**Step 2- What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?**

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-PS3-3. **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.]

**Step 3- What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?**

**Science and Engineering Practices**

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

**Constructing Explanations and Designing Solutions**
Use evidence (e.g., measurements, observations, patterns) to construct an explanation. (4-PS3-1) 
Apply scientific ideas to solve design problems.  (4-PS3-4)
Disciplinary Core Ideas

PS3.A: Definitions of Energy
- 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-PS3-3)

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-PS3-3)

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)

EST1.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-PS3-3), (4-PS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World
- Engineers improve existing technologies or develop new ones. (4-PS3-4)

Connections to Nature of Science

Science is a Human Endeavor
- Most scientist and engineers work in teams. (4-PS3-4)
- Science affects everyday life. (4-PS3-4)

CCSS-ELA and CCSS-M Connected Standards

<table>
<thead>
<tr>
<th>English Language Arts / Literacy</th>
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<tbody>
<tr>
<td>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)</td>
</tr>
<tr>
<td>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)</td>
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<tr>
<td>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)</td>
</tr>
<tr>
<td>W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1)</td>
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Grade 4 Example  **NGSS Topic: 4. Energy**

| 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) |

**Step 4 - What understandings need to be developed for students to be successful in the performance expectation(s)? What content ideas will they need to know and what skills will they need to learn?**

<table>
<thead>
<tr>
<th>Students will need to know…</th>
<th>Students will be able to…</th>
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<tbody>
<tr>
<td>The faster a given object is moving, the more energy it possesses.</td>
<td>Write a scientific explanation supported by evidence for how energy in a model changes based on the speed of the moving object.</td>
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<tr>
<td>Energy can be moved from place to place by moving objects or through sound, light, or electric currents.</td>
<td>Draw a picture or use physical objects, including electric circuits, to demonstrate the movement of energy from one place to another. Identify the energy that is moving (objects in motion, sound, light, or electric) or the combination of them.</td>
</tr>
<tr>
<td>Energy is present whenever there are moving objects, sound, light, or heat.</td>
<td>Four different types of energy are described - from motion of object, sound light heat - Describe Examples of each type of energy.</td>
</tr>
<tr>
<td><strong>When objects collide, energy can be transferred from one object to another, thereby changing their motion.</strong></td>
<td>Explain how energy can be transferred from object to object and through sound light and electric currents.</td>
</tr>
<tr>
<td>In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.</td>
<td>The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.</td>
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<td>The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.</td>
<td>Identify the common language and how it is used but is inconsistent with scientific understand of energy.</td>
</tr>
</tbody>
</table>
Step 5: What Science and Engineering Practices are appropriate with the instruction of the disciplinary core ideas?
- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions
- Analyze and Interpret Data
- Argue from Evidence

Step 6: What are the lesson level expectations (learning performances) and how will they build to meet the performance expectations?
1. Define and solve problems of moving/transfer of energy from one object to another. (Asking questions and defining problems)
2. Define a problem of loss of energy when the energy of a moving object changes to sound, light or heat. (Asking question and defining problems)
3. Create an investigation that relates motion of an object to energy and minimizes the energy transferred. (Planning and carrying out investigations)
4. Develop a model that represents the changes in motion and energy of an object and use the model to predict the energy present in an object with different motion, when an object speeds up or slows down. (Developing and using a model)
5. Construct a scientific explanation (create a claim and support the claim with evidence from the investigation) relating the motion of an object to the energy it possesses. (Constructing a scientific explanation)
6. Design a solution to a problem of limiting the amount of energy transferred from one object to another, motion, heat, light, or sound. (Asking questions and defining solutions)
7. Construct an argument, supported by evidence, for one form of alternative energy. Include environmental impact of decision. (Engaging in argument from evidence)

Step 7: What assessment (formative and summative) will provide evidence of the understanding and/or ability to perform lesson level expectations (learning performances)?
1. Students will draw a picture of their solution. They will accurately represent the movement of energy of moving objects using arrows to show direction and labels to identify that energy is moving from greater to lesser. They will annotate their drawing to identify the changes in energy.
2. Given a picture or video of a machine that is losing energy as sound, light, or heat, students will accurately identify where the energy is being lost and the types of energy transformations that are happening.
3. Students will identify an object in motion (toy car, roller skate, ball, desk chair, etc.) and design an investigation that relates the motion of the object to energy transferred. The investigation will include at least one way in which the energy can be conserved (wax the surface, reduce friction in the wheels). Students will analyze gathered data, identify trends, and share conclusions with others. They will write a scientific explanation in the CER format to explain their results.
4. For the investigation above, students will draw a picture of their experiment and use the picture to explain what would happen if their object in #3 were to be changed in mass or speed.
5. In conjunction with #3, students will write a scientific explanation in the CER format to explain the phenomenon.
6. Students’ arguments (#7) will include scientific evidence, comments from knowledgeable sources, and critical data to support their argument.
Step 8 What is the storyline that helps learners apply what they know, build new, sophisticated ideas from observation and evidence, and use information to solve an engineering problem?

In grade 1, students learn that energy from the sun is responsible for the food that animals, including people, eat. When they enter fourth grade, students deepen their understanding in a number of ways.

Energy in the motion of objects is embedded in two performance expectations (4-PS1-1 and 4-PS1-3). Students can ask questions about and investigate indicators of energy, speed, distance, and ability to push, can be linked to changes in mass, height (for a coaster car) to represent differences in energy. Using diagrams, experiments, and investigations, students can begin to see the relationships between factors that influence energy and indicators of energy.

Experiencing multiple ways in which energy is transferred from one object to another and from place to place is also critical for deep understanding of the Disciplinary Core Ideas, Practices and Crosscutting Concepts embedded within 4-PS3-4. Collisions between objects in motion can be connected to changes in motion and to sound at the time of collision. Percussion instruments also provide an opportunity to better understand the connection between volume and energy and the transfer from energy of motion to sound.

Step 9 Reflect- How do the lessons and tasks help students move towards an understanding of the performance expectation(s)?

Students will use a coaster car to investigate motion of an object and the relationship of that motion to the energy the car possesses. Through scaffolded investigations, students will change the motion of the car and collect data about how the car motion changes given different ramp heights. They will also explore how the energy of the car can be transferred through collisions. Through these explorations, students will generate questions to investigate. The questions will support the developing understanding of the relationships between energy and the motion of the car, transfer of energy through collisions and sound.

Additional challenges will provide opportunities to encourage students to use their collected data to create models of the energy in other objects, for example roller coaster cars or different masses of vehicles. The discussion and use of the models allows students to deepen their understanding of the ways in which energy is increased and then transferred between objects.