Christi Hamilton

Energy Unit – 6th Grade

Specific Unit – 6th Grade Energy

Specific Lesson – Kinetic and Potential Energy

Big Idea – Kinetic and potential energy are foundational energy sources and must be understood in order to really understand energy itself.

Explanation:

Energy is an exciting subject, by definition. Things always move. They jump, dive, hop, burst. Energy does the most amazing things. What many people don't realize is that things doing nothing also have energy, it's just energy waiting to be used. It's energy stored. Those things we always see moving and jumping, diving and bursting, those are examples (perhaps rather extreme ones) of ***kinetic*** energy, which is energy in motion. We always think of energy as this dynamic, if not, explosive force, right? But no! Energy is also stored in everything around us. There is energy stored in that book sitting on that table you see over there. Does it have to be teetering on the edge, about to fall off? No. It's still full of energy laying securely right in the middle of that table. What about that great big rooster statue on the top of the hill on the way in to town? That old chicken has been there for years and years. It never moves, or at least it hasn't yet. But that doesn't mean it isn't full of that stored energy we call ***potential*** energy. The difference is pretty easy, one moves and the other waits.

Anchoring question(s):

Why do things move? What makes them move faster? Why do they sit still? If they are full of energy, why are they just sitting there? Does having energy mean that something has to be in motion?

We have a series of evolving questions here which show an evolution in a student's thinking as they consider energy and how it actually works/exists. This leads to a student's distinction between kinetic and potential energy as they begin to recognize that an object possessing energy doesn't mean an object is moving.

Standards:

Students who demonstrate understanding can:

MS-PS3-2. **Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.** [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [*Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to describe unobservable mechanisms.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- A system of objects may also contain stored (potential) energy, depending on their relative positions.

PS3.C: Relationship Between Energy and Forces

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

Connections to other DCIs in this grade-band: N/A

Articulation of DCIs across grade-bands:
HS.PS2.B ; **HS.PS3.B** ; **HS.PS3.C**

Common Core State Standards Connections:
ELA/Literacy -
SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-PS3-2)*

Students who demonstrate understanding can:

MS-PS3-3. **Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*** [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

The performance expectation above was 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

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

PS3.B: Conservation of Energy and Energy Transfer

- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

ETS1.A: Defining and Delimiting an Engineering Problem

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. *(secondary)*

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary)*

Crosscutting Concepts

Energy and Matter

- The transfer of energy can be tracked as energy flows through a designed or natural system.

Connections to other DCIs in this grade-band:
MS.PS1.B ; **MS.ESS2.A** ; **MS.ESS2.C** ; **MS.ESS2.D**

Articulation of DCIs across grade-bands:

4.PS3.B ; **HS.PS3.B**

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. *(MS-PS3-3)*
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3)

Students who demonstrate understanding can:

MS-PS3-5. **Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.** [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [*Assessment Boundary: Assessment does not include calculations of energy.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds.

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

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Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations

Disciplinary Core Ideas

PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

Crosscutting Concepts

Energy and Matter

- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Connections to other DCIs in this grade-band:

MS.PS2.A

Articulation of DCIs across grade-bands:

4.PS3.C ; **HS.PS3.A** ; **HS.PS3.B**

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. *(MS-PS3-5)*
WHST.6-8.1	Write arguments focused on discipline content. *(MS-PS3-5)*

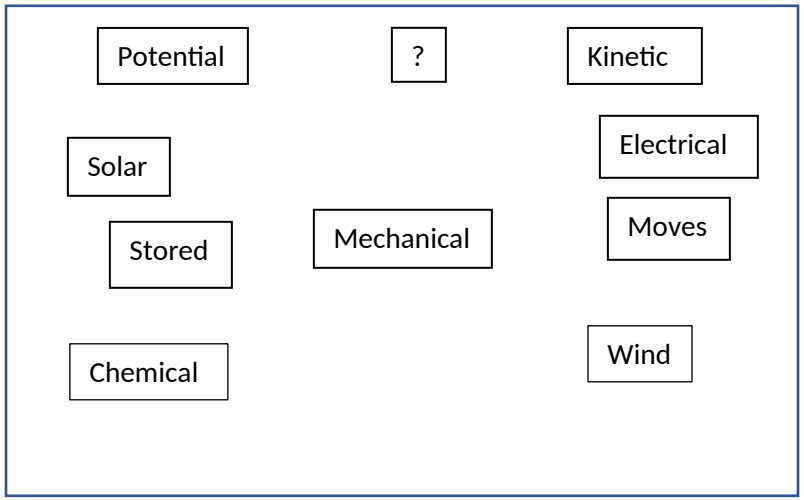
Mathematics -

MP.2	Reason abstractly and quantitatively. (MS-PS3-5)

6.RP.A.1	Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. *(MS-PS3-5)*
7.RP.A.2	Recognize and represent proportional relationships between quantities. *(MS-PS3-5)*
8.F.A.3	Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *(MS-PS3-5)*

Discourse Strategy:

Throughout this lesson, students will complete a learning board, using poster paper and post-it notes. As we learn more information about potential and kinetic energy students will be asked to contribute at least one idea to the board at the end of each exercise. They will also be asked to discuss previous ideas in order to determine if those ideas are still accurate or if they might need to be re-evaluated. Adding their own ideas and discussing ideas others have as we move forward through this lesson will help students make sense of what they are learning. Placing those ideas on the board helps students visualize what is being discussed. Students are also encouraged to create drawings of their ideas to tape up near the board. By the end of the lesson, students should have many post-it notes attached to the poster paper in order to create an in-depth discussion about what kinetic and potential energy are and how they transform between one another.



Wind energy captured by the turbine and transferred into electrical energy. These are forms of kinetic energy.

Thermal energy from the sun captured by solar panels transferred to a battery and then to electrical energy. Thermal energy, solar energy, and chemical energy stored in the panel and the battery are potential energy and the electrical energy in the power lines is kinetic energy.