4.Energy

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Students who demonstrate understanding can:

4-PS3-a. **Construct an argument using evidence about the relationship between the change in motion and the change in energy of an object.** [Assessment Boundary: No attempt is made to give a precise or quantitative definition of energy. Students should not be assessed on quantitative measures of changes.]

4-PS3-c. **Formulate questions and predict outcomes about the change in energy that can occur between colliding objects and/or magnet interactions.** [Clarification Statement: Emphasis is on the change in the energy, not on the forces, as objects interact.] [Assessment Boundary: Quantitative measurements of energy are beyond the scope of assessment.]

4-PS3-b. **Make observations and collect data to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** [Assessment Boundary: Quantitative measurements of energy are beyond the scope of assessment.]

4-PS3-d. **Use information from texts and diagrams to communicate that scientists and engineers from diverse backgrounds have applied scientific discoveries to invent technologies to enable humans to transport and store energy for practical use in daily life.*** [Clarification Statement: Examples of technology that allows humans to transport and store energy could include batteries in electrical devices, power grids, and gasoline stations.]

4-PS3-e. **Design, test, and refine a device based on the criterion that it converts energy from one form to another with a given set of constraints to solve a real world problem.*** [Clarification Statement: Examples of devices could include a vehicle that converts electrical energy into motion energy of the vehicle or a passive solar heater that converts light into heat. Examples of constraints could include the materials to be used, the cost of the device, or the time to complete the design.]

4-ESS3-a. **Construct a model using abstract representations and examples to describe differences between renewable and non-renewable sources of energy.***

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.

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

Developing and Using Models

Modeling in 3–5 builds on K–2 models 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 or design solution. (4-ESS3-a)

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 and/or measurements, collect appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (4-PS3-b)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.

- Apply scientific knowledge to solve design problems. (4-PS3-e)

Engaging in Argument from Evidence

Engaging in argument from evidence in 3–5 builds from 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.

- Construct and/or support scientific arguments with evidence, data, and/or a model. (4-PS3-a)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 and progresses to evaluating the merit and accuracy of ideas and methods.

- Combine information in written text with that contained in corresponding tables, diagrams, and/or charts. (4-PS3-d)
- Use multiple sources to generate and communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts. (4-PS3-d)

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- The faster a given object is moving, the more energy it possesses. (4-PS3-a)
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.) (4-PS3-b)

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-b)
- Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to the earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth. (4-PS3-b)
- 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 (e.g., moving water driving a spinning turbine which generates electric currents). (4-PS3-b)

PS3.C: Relationship Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motions. Magnets can exert forces on other magnets or on magnetizable materials, causing energy transfer between them (e.g., leading to changes in motion) even when the objects are not touching. (4-PS3-c)

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—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity. (4-PS3-d)
- It is important to be able to concentrate energy so that it is available for use where and when it is needed. For example, batteries are physically transportable energy storage devices, whereas electricity generated by power plants is transferred from place to place through distribution systems. (4-PS3-d)

ESS3.A: Natural Resources

- All materials, 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-a)

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. (4-PS3-e)

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects. (4-PS3-a),(4-PS3-c),(4-PS3-b),(4-PS3-d),(4-PS3-e)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discovieries lead to the development of new technologies. (4-PS3-d)

Influence of Science, Engineering and Technology on Society and the Natural World

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

Connections to Nature of Science

Science is a Human Endeavor

- Men and women choose careers as scientists and engineers. (4-PS3-b)
- Most scientists and engineers work in teams. (4-PS3-b)
- Science affects everyday life. (4-PS3-b)

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