FOURTH GRADE: FORCE AND MOTION

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon potential for related phenomena that can be used throughout a unit.

4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object. (SEP: 6; DCI: PS3.A; CCC: Energy/Matter). [*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. (SEP: 1; DCI: PS3.A, PS3.B, PS3.C; CCC: Energy/Matter) [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.]*

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

An object's speed is related to the energy it possesses. Objects moving faster possess more energy than objects moving slower. The energy of objects when they collide with each other can be predicted.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- NASCAR crashes.
- Bumper cars or boats.
- Speed zones near schools.
- Seatbelts.
- Game of marbles.

Storyline

This section aims to decode not only the DCI connections, but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions ● Use evidence (e.g., measurements, observations, patterns) to construct an explanation. ● Apply scientific ideas to solve design problems. **Asking Questions and Defining Problems** ● Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	**PS3.A: Definitions of Energy** ● The faster a given object is moving, the more energy it possesses. ● Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **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. **PS3.C: Relationship Between Energy and Forces** ● When objects collide, the contact forces transfer energy so as to change the object's' motions.	**Energy and Matter** ● Energy can be transferred in various ways and between objects

Students plan and conduct investigations that provide evidence that the speed of an object is related to the energy of that object. Students practice observing objects at different speeds and colliding with different objects. Students observe the effects of the collisions and consider what is happening and what patterns they see. They can develop questions based on those observations. Questions to consider are what is the input and output of the system the objects are in? Where is the force coming from? How is the energy transferred? Does the object speed up or slow down?

Students record observations, develop a model, and construct explanations. They will use this evidence to predict that the object with greater speed slows down after a collision and the object with lesser speed moves faster after a collision. Students communicate and start to predict the outcomes of the changes of speed and energy. This should lead students to the understanding of objects with a greater speed have more energy than an object with lesser speed.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard or lesson-level performance expectation.

Resources to inform your formative assessment.

http://stemteachingtools.org/brief/30
http://stemteachingtools.org/brief/41
http://stemteachingtools.org/pd/sessionb

SEP Asking Questions and Defining Problems

- Students pose questions after observing objects moving at different speeds and colliding with stationary objects.
- What happens to the object with greater speed after it collides with a slower and/or non-moving object after a collision? How does that compare to the slower or the non-moving object.

SEP Constructing Explanations and Designing Solutions

- Write an evidence-based that the speed of an object is related to the energy of that object.
- Why do we use seatbelts?
- Why are speed limits usually 15 MPH in school zones?
- How are NASCAR cars modified to reduce injuries to drivers in crashes involving high speeds?

CCC Energy and Matter

- Use a model to communicate that objects with greater energy transfer some of the energy to the object with lesser energy within the system.

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain-size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Design a solution** that will hold an object in place when it *collides* with another moving object at different speeds.
- **Develop questions** based on the observations of the interactions of a variety of objects and their *reactions to collisions*.
- **Predict** *how objects will react* when they collide at different speeds.