THIRD 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.

3-PS2-1 Plan and carry out an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. (SEP: 3; DCI: PS2.A, PS2.B; CCC: Cause/Effect) [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] *[Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]*

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence for how a pattern can be used to predict future motion. (SEP: 3; DCI: PS2.A; CCC: Patterns) [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] *[Assessment Boundary: Assessment does not include technical terms such as period and frequency.]*

Content Overview

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

All forces have strength and direction. If the object is not moving it may have multiple, balanced and opposite forces acting on it. The sum of those forces would be zero. If the forces do not add up to zero (are not balanced), this can cause changes in the object's speed and/or direction of motion. Objects in contact with each other exert forces on each other. These patterns can be observed and measured by students planning and carrying out investigations. Regular patterns in the change of motion and the cause and effect of those patterns can predict future motion.

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.

- Game of marbles.
- Activities on the playground, for example swinging on a swing, a seesaw, a ball rolling back and forth.
- Observing pendulum length and weight.
- Newton's cradle motion.
- Playing a sport: Soccer, baseball, kickball, football, basketball, etc.

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
Planning and Carrying Out Investigations ● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. ● Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**PS2.A: Forces and Motion** ● Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) ● The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) **PS2.B: Types of Interactions** ● Objects in contact exert forces on each other.	**Cause and Effect** ● Cause and effect relationships are routinely identified. **Patterns** ● Patterns of change can be used to make predictions.

Students can plan and conduct investigations to observe and measure motion of objects. Students begin to ask questions about the causes of those patterns in motion. Students can observe objects and how they interact with each other. Students observe objects remaining at rest when the forces being applied to them are equal and objects are in motion when the forces being applied are not equal. Students will make observations about the objects around them

remaining at rest. Students begin to consider the system the object is in and how the multiple forces in the system act on the object. For example, a marble on the floor has a force acting on the marble pulling it down as well as a surface force from the floor pushing it up. These forces are balanced and create a situation where the marble is at rest. If another force is applied to the marble, or one of the existing forces is removed, the forces are then unbalanced and the marble will no longer be at rest, but will move.

Students can plan and carry out investigations to make observations about the effects of balanced and unbalanced forces on a variety of objects. They can use evidence from the investigations to explain how balanced and unbalanced forces impact objects. Students can also measure and observe the forces on objects to provide evidence that forces have strength and direction. For example students can push a marble fast or slow or from the back or side. Students can connect these observations about strength and direction of forces to claims about causes for change in the motion of objects. Students can then begin to see that motions of objects are predictable. Through their observations and measurements, students can see patterns in the motion of objects and be able to predict an object's motion.

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 Planning and Carrying Out Investigations

- Observe and record marbles when equal forces are applied and when unequal forces are applied.
- Observe patterns in motion of objects and predict an object's motion.
- Plan and carry out investigations to make observations about the effects of balanced and unbalanced forces on a variety of objects.
- Measure and observe the forces on objects to provide evidence that forces have strength and direction.

CCC Patterns

- How can an object at rest have multiple forces acting on it?
- Observe patterns of objects and predict an object's motion.

CCC Cause and Effect

- What effect does a balanced force have on an object?
- What effect does an unbalanced force have on an object?
- What is the cause and effect relationship present in a Newton's Cradle?
- Describe the effects of different forces on an object's starting, stopping, or changing direction.

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.

- **Make observations and measurements** of an object's motion and identify *patterns* to **provide evidence** of balanced and unbalanced forces.
- **Plan and carry out an investigation** to collect evidence on the *effects of* the directions and sizes of balanced and unbalanced forces on an object's motion.
- **Plan and carry out an investigation** using objects to find *patterns* and to predict future motions.
- **Ask questions** about what *causes* objects to be at rest or in motion .