Forces and Motion

Connecting Learning and Standards

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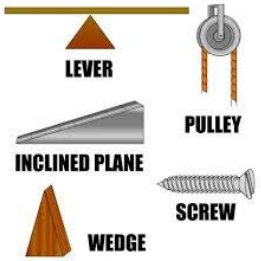
Forces and Motion

Students explore Forces and Motion with twelve hands-on activities. Students use a push-pull meter to measure force. They compare the relative work of moving identical objects different distances and different objects identical distances. Then students discover how simple machines make work easier by reducing the amount of force needed.

They lift with levers, roll with wheels and axles, and raise objects with fixed and movable pulleys. They drag loads up inclined planes, separate objects with wedges, and secure wood blocks with screws. In a teacher demonstration, they see how a spring scale works. Students crank gears, decrease friction, and investigate household gadgets to identify what makes them labor-saving devices, supported by reading about the relationship between force, motion, and work. They learn about the six simple machines



- Lever
- Wheel and axle
- Pulley
- Inclined plane
- Wedge
- Screw

and how these machines help people do work by moving objects easier, faster, or farther.

They also read about people in science "bicycle inventors" and how they created ways to make the bicycle an increasingly more complex (and safe) machine. Finally, students find out how the waterwheel works and how friction affects motion[1].

Students will

- Compare and contrast a variety of machines
- Classify information by understanding the difference between first-, second-, and third-class levers
- Recognize cause and effect relationships having to do with how simple machines work.
- Demonstrate critical thinking
- Interpret graphic devices
- Summarize concepts and learning

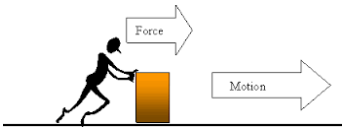
[1] http://delta-education.com/productdetail.aspx?Collection=Y&prodID=1111&menuID=12&topID=&subID=71 (Accessed August 2015)

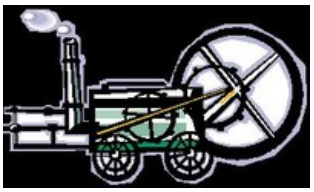
Reading for information is a key literacy skill. The unit contains sections to review and assess hands-on learning activities as well as writing link suggestions to develop critical thinking skills.

Lessons are designed for students to:

- Discover facts about force, motion and friction
- Identify the six simple machines and how they work
- Discuss the function of a table of contents, heading, and glossary
- Interpret photographs and diagrams to answer queations
- Complete a KWL chart
- Organize information in different ways

Content Vocabulary

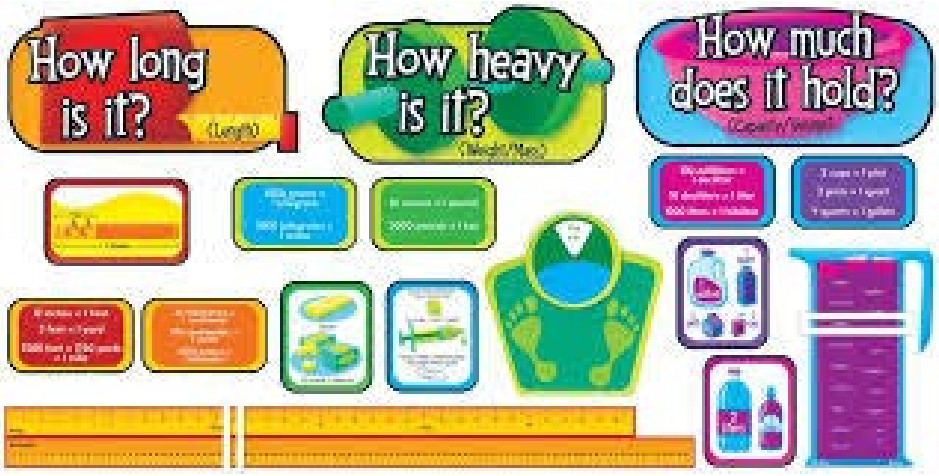
direction	force	inclined plane	newton	speed
distance	friction	lever	pivot	spring scale
effort	fulcrum	load	position	wedge
energy	gravity	lubricant	pulley	weight
		machine	screw	wheel and axle
		motion	simple machine	work



Common Core State Standards Connections

ELA/Literacy		Forces and Motion
CCSS.ELA-LITERACY.RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.	Read for information to communicate and make conclusion based on data
CCSS.ELA-LITERACY.RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.	Understand the history and impact of simple machines by making and using models to observe cause and effect. Read about the history and development of a simple machine.
CCSS.ELA-LITERACY.RI.3.8	Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).	Develop an idea based on past observations and experiences. State the outcome of a future event using observations and experiences.
CCSS.ELA-LITERACY.W.3.7	Conduct short research projects that build knowledge about a topic.	Experiment using safe procedures, identifying and controlling factors that may affect the outcome of different variables.
CCSS.ELA-LITERACY.W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.	Collect, classify, record, and compare information about observations and measurements.
CCSS.ELA-LITERACY.SL.3.3	Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.	Communicate and share information or ideas orally, in writing, or by using graphic organizers.

Mathematics		Forces and Motion
CCSS.MATH.PRACTICE.MP2	Reason abstractly and quantitatively.	Group objects, information, systems, or events into categories based on their properties or by using a logical method.
CCSS.MATH.PRACTICE.MP5	Use appropriate tools strategically.	Use different objects to make and use models in developing concepts.
CCSS.MATH.CONTENT.3.MD.A.2	Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	Count, order, estimate and calculate based on quantitative information using standard units. Communicate information and ideas about observations and measurements. Gather and share information about observations and measurements to infer, predict, and make conclusions.



New York State Standards Connections
Elementary Science Core Curriculum

Key Idea 5: Energy and matter interact through forces that result in changes in motion.

Students should be able to observe and describe relative positions between objects in their world. Exploring the observable effects of gravity and magnetism may help students develop an understanding of the reason for the direction of an object's motion. Manipulation and application of simple tools and machines may help students learn about the relationships between forces and motion.

NYS Science Standard		Forces and Motion
Performance Indicator 5.1 Describe the effects of common forces (pushes and pulls) of objects, such as those caused by gravity, magnetism, and mechanical forces.	5.1a The position of an object can be described by locating it relative to another object or the background (e.g., on top of, next to, over, under, etc.) 5.1b The position or direction of motion of an object can be changed by pushing or pulling. 5.1c The force of gravity pulls objects toward the center of Earth. 5.1d The amount of change in the motion of an object is affected by friction. 5.1f Mechanical energy may cause change in motion through the application of force and through the use of simple machines such as pulleys, levers, and inclined planes.	Make and use devices to compare, predict and infer the effects of forces and motion. Identify the elements needed for work to be accomplished. Measure and observe the amount of force to move various objects. Forces such as gravity effect the position and motion of objects. Observe, measure, and compare the effects of friction on a moving object. Determine ways to reduce friction between an object and the surface over which it moves. Engage in activities using the six types of simple machines. Explain how machines reduce work and discuss the features that make them simple machines.

FORCES AND MOTION

PS2: Motion and Stability: Forces and Interactions

Next Generation Science Standards		Forces and Motion
3-PS2-1.	Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [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.*]	Experiment using safe procedures, identifying and controlling factors that may affect the outcome of different variables using simple machines. Observe the effects of friction and lubrication on a moving object, the amount of force to lift a load, the transfer of force, change in the direction of force, and the tradeoff between force and distance.
3-PS2-2.	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. [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.*]	Make and use devices to compare, predict and infer the effects of forces and motion. Communicate information and ideas about observations and measurements. Gather and share information about observations and measurements to infer, predict, and make conclusions.

3-PS2 Motion and Stability: Forces and Interactions

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

Science and Engineering Practices

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

- Ask questions that can be investigated based on patterns such as cause and effect relationships. (3-PS2-3)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4)

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.

- 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. (3-PS2-1)
- 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. (3-PS2-2)

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Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns. (3-PS2-2)

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods, tools, and techniques. (3-PS2-1)

Disciplinary Core Ideas

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.) (3-PS2-1)
- 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.) (3-PS2-2)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other. (3-PS2-1)
- Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)

Crosscutting Concepts

Patterns

- Patterns of change can be used to make predictions. (3-PS2-2)

Cause and Effect

- Cause and effect relationships are routinely identified. (3-PS2-1)
- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-3)

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Connections to Engineering,Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-4)

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
K.PS2.A (3-PS2-1); **K.PS2.B** (3-PS2-1); **K.PS3.C** (3-PS2-1); **K.ETS1.A** (3-PS2-4); **1.ESS1.A** (3-PS2-2); **4.PS4.A** (3-PS2-2); **4.ETS1.A** (3-PS2-4); **5.PS2.B** (3-PS2-1); **MS.PS2.A** (3-PS2-1),(3-PS2-2); **MS.PS2.B** (3-PS2-3),(3-PS2-4); **MS.ESS1.B** (3-PS2-1),(3-PS2-2); **MS.ESS2.C** (3-PS2-1)

Scheduling and Contact Information

BoSAT Elementary Science is a resource for the classroom teacher to aid in the implementation of a “hands on” approach to teaching elementary science. BoSAT provides staff development, classroom support, science kits and materials for grades K-6. Kits are available in the areas of life, earth and physical science.

The BOCES #1 Science and Technology (BoSAT) Center provides subscribing districts with an interdisciplinary science curriculum that emphasizes the process skills of:

- Observing
- Classifying
- Measuring
- Collecting and Processing Data
- Predicting and Inferring
- Experimenting
- Creating Models
- Making Decisions
- Replicating
- Manipulating Materials

In addition, our resources include

- teacher in-service programs where teachers are provided learning theory, teaching strategies, classroom management and assessment
- flexible program for elementary science where each school district selects the science kits and programs that best fit their curriculum, including science kits, video conferencing, and mobile science lab.
- student centered programs where students are active learners and are provided opportunities to design experiments of their own choosing

Give us a call for further information or to ship a kit of hand-on experiments to you.

To view kit descriptions and order go to: http://www.bosat.org/

Please contact Debra Croce at debra_croce@boces.monroe.edu or (585)249-7063 for pricing and scheduling information.

Contact Steve Orcutt at steve_orcutt@boces.monroe.edu or (585) 249-7890 for more information about programs and curriculum.

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