Science Curriculum

Kindergarten Unit Three:

FOSS Materials and Motion
Course Description

In unit one, students engage in an engineering challenge to develop habits of mind and classroom practices that will be reinforced throughout the school year. In unit two, students engage in systematic investigations of trees over the seasons that will bring students to a better understanding of the place of trees at school and in the community. Students will observe day-to-day changes in weather over the year, as well as the impact weather has on living things. Students will develop an understanding of what plants (and animals) need to survive and the relationship between their needs and where they live. By monitoring local weather, students experience the patterns and variations in weather and come to understand the importance of weather forecasts to prepare for severe weather. In unit three, students study natural resources and properties of materials and how those properties determine their use—wood, paper, and fabric. Students come to understand that humans use natural resources for everything they do and that people affect the world around them. Students use those materials to engineer structures, applying physical science core ideas of energy transfer. After building a repertoire of practices with materials, students investigate the effect of pushes and pulls, and apply their intuitive notion of the concept of variables to change the strength and direction of rolling balls to achieve specific outcomes. In unit four, students observe and describe the structures of fish, birds, snails, earthworms, and isopods. Appropriate classroom habitats are established, and students learn to care for the animals. In four investigations, animals are studied in pairs. Students observe and care for one animal over time, and then they are introduced to another animal similar to the first but with differences in structure and behavior. Students learn what animals need to survive and the relationship between their needs and where they live. The firsthand experiences are enriched with close-up photos of animals, some related to animals that students have observed in class and some to animals that are new. This process enhances observation, communication, and comparison. Throughout all units, students engage in science and engineering practices by asking questions, participating in collaborative investigations, observing, recording, and interpreting data to build explanations, and obtaining information from photographs. Students gain experiences that will contribute to an understanding of the crosscutting concepts of patterns; cause and effect; systems and system models; and structure and function.
Teachers may choose from a variety of instructional approaches that are aligned with 3 dimensional learning to achieve this goal. These approaches include:

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<tr>
<th>Inquiry Kit Instruction (modified)</th>
<th>Challenge Based Instruction</th>
<th>5 E Instructional Model (BSCS)</th>
<th>Culturally Relevant Instruction</th>
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<tr>
<td>Project-Based Instruction</td>
<td>Tinkering Pedagogy</td>
<td>Learning Progressions</td>
<td>Knowledge Integration</td>
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<td>Model-based Reasoning</td>
<td>Place-based Instruction</td>
<td>Meaningful Expertise Instruction</td>
<td>Emergent Investigations (RSS)</td>
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Unit Summary

The **Materials and Motion Module** provides Kindergarten students with integrated experiences with physical science, earth science, and engineering core ideas that relate to students’ interests and are teachable and learnable. We begin with a study of natural resources and properties of materials and how those properties determine their use—wood, paper, and fabric. Students come to understand that humans use natural resources for everything they do and that people affect the world around them. Students use those materials to engineer structures, applying physical science core ideas of energy transfer.

After building a repertoire of practices with materials, students investigate the effect of pushes and pulls, and apply their intuitive notion of the concept of variables to change the strength and direction of rolling balls to achieve specific outcomes.

Throughout the **Materials and Motion Module**, students engage in science and engineering practices by asking questions, participating in collaborative investigations, observing, recording, and interpreting data to build explanations, and designing objects and systems to achieve specific outcomes. Students gain experiences that will contribute to beginning-level understanding of the crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter, and structure and function.
<table>
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<tr>
<th>Student Learning Objectives</th>
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<tbody>
<tr>
<td><strong>Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.</strong> [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.] <em>(K-PS2-1)</em></td>
</tr>
<tr>
<td><strong>Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.</strong> [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.] <em>(K-PS2-2)</em></td>
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<tr>
<td><strong>Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.</strong> <em>(K-ESS3-3)</em></td>
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<tr>
<td><strong>Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.</strong> <em>(2-PS1-2)</em></td>
</tr>
<tr>
<td><strong>Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.</strong> <em>(K-2 ETS1-1)</em></td>
</tr>
<tr>
<td><strong>Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.</strong> <em>(K-2-ETS1-2)</em></td>
</tr>
<tr>
<td><strong>Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.</strong> <em>(K-2-ETS1-3)</em></td>
</tr>
<tr>
<td>NJDOE Student Learning Objective</td>
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<tr>
<td>--------------------------------</td>
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<tr>
<td><strong>Investigation 1 Part 1: Observing Wood</strong></td>
</tr>
<tr>
<td><strong>Investigation 1 Part 2: Wood and Water</strong></td>
</tr>
<tr>
<td><strong>Investigation 1 Part 3: Testing a Raft</strong></td>
</tr>
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</table>
| should be used to make a | passengers.  
| raft.  
| 2-PS1-2, K-2-ETS1-1, K-1-2, K-2-ETS1-3 | Embedded Assessment:  
| Teacher observation |  |

**Investigation 1 Part 4: Sanding Wood**

Students gather evidence regarding how the properties of wood can be changed by sanding.

2-PS1-2, K-ESS3-3

| How can you change the shape of wood? | How are sawdust and shavings the same? How are sawdust and shavings different? | Students compare sawdust and shavings. They find out what happens to sawdust and shavings when they mix the two with water and then separate out the shavings. Students spread out wet sawdust on paper plates and observe it after a few days.  
|  |  | Embedded Assessment:  
| Teacher observation | Video:  
| What Is Agriculture? |  |

| Wood can be changed by (appearance and behavior) by mechanical action, such as sanding and mixing with water.  
| Sawdust is tiny wood pieces that can be recycled. | Wood floats in water but can be made to sink.  
| Wood can be changed by (appearance and behavior) by mechanical action, such as sanding and mixing with water.  
| Wood that is waterlogged sinks. | Different kinds of wood come from different kinds of trees. Trees are natural resources.  
| Some kinds of wood are processed and made by people.  
| Sawdust is tiny wood pieces that can be recycled.  
| Basic materials can be transformed into | Students simulate the making of particleboard by using sawdust and a cornstarch matrix. They compare their particleboard with the samples from the kit.  
| Embedded Assessment:  
| Teacher observation |  |

**Science Resources**

Book:  
"Are You an Engineer?"
<table>
<thead>
<tr>
<th>Investigation 1 Part 7: Making Plywood</th>
<th>How is plywood made?</th>
<th>Students make plywood from thin strips of wood and glue. They compare the breakable strength of a craft stick to that of their homemade plywood.</th>
<th>Embedded Assessment: Teacher observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students explore one means to reduce the waste of wood as a natural resource by creating plywood.</td>
<td>● Different kinds of wood come from different kinds of trees. Trees are natural resources. Some kinds of wood are processed and made by people. ● Gluing (laminating) thin sheets of wood together produces strong wood that is harder to break.</td>
<td>2-PS1-2, K-ESS3-3</td>
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<table>
<thead>
<tr>
<th>Investigation 2 Part 1: Paper Hunt</th>
<th>What is made of paper?</th>
<th>Students observe and compare the properties of ten kinds of paper. They go on a paper hunt, looking for a sample that matches one that they are given. Students place labels around the classroom to highlight all the items in their environment made of paper.</th>
<th>Embedded Assessment: Teacher observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students gather evidence regarding the properties of paper.</td>
<td>● Paper has many observable properties. ● Many objects are made from paper. ● People make paper from wood.</td>
<td>2-PS1-2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investigation 2 Part 2: Using Paper</th>
<th>What makes paper good for writing? What makes paper easy to fold?</th>
<th>Students use crayons, pencils, and marking pens to explore and compare the properties of paper that make it suitable or unsuitable for writing and drawing. Students fold paper and compare the properties of paper that allow it to be folded.</th>
<th>Embedded Assessment: Teacher observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students test paper samples to determine which are best for writing, drawing and folding.</td>
<td>● Paper has many observable properties. ● The properties of papers determine their uses.</td>
<td>2-PS1-2, K-2-ETS1-3</td>
<td></td>
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</tbody>
</table>

Science Resources Book: “The Story of a Box”
Online Activity: “Where is Wood?”
### Investigation 2 Part 3: Paper and Water

Students gather evidence regarding the properties of paper when it is exposed to water.

#### 2-PS1-2

| What happens when water gets on paper? | ● Paper has many observable properties.  
● Some kinds of paper absorb water, while others do not. Some paper changes when soaked in water. Some paper breaks down into small fibers. | Students drop water on ten different paper samples and observe and compare the results. They submerge the paper in water and let it dry to see if the paper changes in any way. Students decorate paper flags and hang them on a string outdoors to observe the paper over time.  
Embedded Assessment: Teacher observation |

### Investigation 2 Part 4: Paper Recycling

Students explore how paper can be reused and recycled to reduce waste.

#### 2-PS1-2, K-ESS3-3

| How can new paper be made from old paper? | ● People make paper from wood.  
● Some kinds of paper absorb water, while others do not. Some paper changes when soaked in water. Some paper breaks down into small fibers.  
● Paper, a resource, can be reused, recycled, and fabricated. | Students are introduced to papermaking and recycling. They shake toilet tissue and water in a bottle to make a pulp and then form it into a new sheet of paper. Students discover that the new paper has many of the properties of the original paper and also has some very different properties.  
Embedded Assessment: Teacher observation |

### Investigation 2 Part 5: Papier-Mâché

Students explore how paper’s properties can be changed using papier-mâché.

#### 2-PS1-2, K-ESS3-3

| How can paper be made strong to form a bowl? | ● Paper, a resource, can be reused, recycled, and fabricated. | Students use wheat paste (flour and water) to mold strips of newspaper over a small container. They use this papier-mâché technique to change the paper from flexible to stiff and strong so it will keep a shape.  
Embedded Assessment: Teacher observation |
### Investigation 3 Part 1: Feely Boxes and Fabric Hunt

**Students gather evidence regarding the properties of various fabrics.**

**2-PS1-2**

- **How are fabrics different?**
- **What is made of fabric?**

- **Fabric is a flexible material with a wide range of properties.**

**Students observe the properties of ten different fabrics (burlap, corduroy, denim, fleece, knit, ripstop nylon, satin, seersucker, sparkle organza, and terry cloth). Students match properties by using feely boxes, hunting for fabric, and locating fabrics that are used in the classroom.**

**Embedded Assessment:**
- Teacher observation

### Investigation 3 Part 2: Taking Fabric Apart

**Students gather further evidence regarding the properties of fabric by exploring how it is made.**

**2-PS1-2**

- **How is fabric made?**

- **Fabric can be made of woven threads.**

**Students investigate the structure of woven fabrics by disassembling and comparing loosely woven burlap and tightly woven wool plaid.**

**Art extension:** Weave fabric on small looms. [https://www.theartofed.com/2013/06/25/3-tips-for-weaving-with-young-students/](https://www.theartofed.com/2013/06/25/3-tips-for-weaving-with-young-students/)

**Embedded Assessment:**
- Teacher observation

**FOSS Science Resources Book:**
- “What is Fabric Made From?”

**FOSS Video:**
- *What Is Agriculture?*

**FOSS Online Activities:**
- “Weave a Pattern”

### Investigation 3 Part 3: Water and Fabric

**Students gather further information regarding the properties of fabric when it is exposed to water.**

**2-PS1-2**

- **What happens when water gets on fabric?**

- **Fabrics can absorb, transmit, or repel water.**

- **Wet fabric dries when water evaporates, leaving the fabric unchanged.**

**Students investigate how fabrics interact with water. They discover the many ways the different fabrics absorb, transmit, and repel water. Students immerse fabric in water and observe that it is unchanged after it dries—the water evaporates.**

**Embedded Assessment:**
- Teacher observation
<table>
<thead>
<tr>
<th>Investigation 3 Part 4: Graphing Fabric Uses</th>
<th>How are different kinds of fabric used?</th>
<th>● The properties of fabrics determine their uses.</th>
<th>Students think about the kinds of fabric that would make a good pair of pants and other items of clothing. They prepare picture graphs that represent their decisions regarding the fabric they would use for different kinds of clothing.</th>
<th>Embedded Assessment: Teacher observation</th>
<th>FOSS Science Resources Book: “How Are Fabrics Used?” “Cloth with Meaning” in Toolkit Texts (Spanish text available on CD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation 4 Part 1: Pushes and Pulls</td>
<td>What causes objects to move?</td>
<td>● Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. ● Gravity pulls things down.</td>
<td>Students observe and describe how a push or pull causes something to move. They roll balls at different speeds (slow and fast) and determine the strength of the push required to achieve a certain speed. They are introduced to gravity as a pulling force.</td>
<td></td>
<td>FOSS Science Resources Book: “Pushes and Pulls”</td>
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</table>
## Kindergarten Unit Three: Materials and Motion

### Instructional Days: 40

<table>
<thead>
<tr>
<th>Investigation 4 Part 2: Colliding Objects</th>
<th>What happens when objects collide?</th>
<th>Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students gather and analyze data regarding how collisions affect the movement of an object. Students develop a plan to modify the movement of an object based upon their data analysis.</td>
<td>Gravity pulls things down.</td>
<td>Students use balls and ramps to achieve different speeds. They explore what happens when a moving ball hits an object. Students change the speed of the ball by changing the slope of the ramp to knock over blocks. They apply their knowledge of ball motion to make a ball land in a particular spot.</td>
</tr>
<tr>
<td>K-PS2-1, K-PS2-2, K-2-ETS1-2, K-2-ETS1-3</td>
<td>A bigger push or pull can make things move faster.</td>
<td>Embedded Assessment: Teacher observation</td>
</tr>
<tr>
<td></td>
<td>When objects touch or collide, they push on one another, which can change motion.</td>
<td>FOSS Science Resources Book: “Collisions”</td>
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</table>

### Investigation 4 Part 3: Rolling Outdoors

<table>
<thead>
<tr>
<th>Where can balls roll on the schoolyard?</th>
<th>Gravity pulls things down.</th>
<th>Students find slopes in the schoolyard that can be used to set balls in motion. Each group uses a plastic bottle as a target to predict the path of a ball on a slope.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students predict the path that a ball will take when set in motion from a particular location.</td>
<td>When objects touch or collide, they push on one another, which can change motion.</td>
<td>Embedded Assessment: Teacher observation</td>
</tr>
<tr>
<td>K-PS2-1, K-PS2-2</td>
<td></td>
<td>FOSS Online Activity “Build a Roller Coaster”</td>
</tr>
</tbody>
</table>

### Investigation 4 Part 4: Balloon Rockets

<table>
<thead>
<tr>
<th>How can we change how far a balloon rocket travels?</th>
<th>Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.</th>
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<tbody>
<tr>
<td>Students gather and analyze data regarding the relationship between speed and force applied</td>
<td>A bigger push or pull can make things move faster.</td>
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<td></td>
<td>When objects touch or collide, they push on one another, which can change motion.</td>
</tr>
<tr>
<td>Students observe a balloon-rocket system to find out how far the air in the balloon will propel the system along the flight line. The class investigates how changing the strength of the push (number of pumps of air in the balloon) changes the speed of the balloon rocket and how far it travels. Students also</td>
<td></td>
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</table>
to an object.

K-PS2-1

observe what happens to the system when it collides with an object on the flight line.

Embedded Assessment: Teacher observation

Unit Project (Choose 1)

**Roller Coaster:** There are two parts to this lesson from the book More Picture Perfect Science Lessons. In the first part learners explore ways to change the speed and direction of a rolling object by building roller coasters out of pipe insulation after reading the book, Roller Coaster by Marla Frazee. In the second part students read I Fall Down by Vicki Cobb and then investigate the idea that gravity affects all objects equally by conducting dropping races with everyday items.

**Ramps 2: Ramp Builder:** This is a multi-day lesson plan that has students design, build, and test their own ramps. Students are introduced to a variety of materials and explore putting them together. Students engage in an inquiry-based learning experience to reinforce math, science, and technology. They create plans for ramps by evaluating a variety of materials provided to them.

What It Looks Like in the Classroom

In this unit of study, students plan and carry out investigations in order to understand the effects of different strengths and different directions of pushes and pulls on the motion of an object. Students will also engage in a portion of the *engineering design process* to determine whether a design solution works as intended to change the speed or direction of an object.

Scientists often design simple tests in order to gather evidence that can be used to understand cause-and-effect relationships. In this unit’s progression of learning, kindergarteners need adult guidance to collaboratively plan and conduct simple investigations to discover and compare the effects of pushes and pulls on the motion of an object. Students will need opportunities to push and pull a variety of objects, such as balls, toy cars, pull toys, cans, tops, and boxes. Students should push/pull these objects first with varying strengths, and then in a variety of directions. They should also explore the effects of pushing objects into one another, as well as into walls and other stationary objects. Students should record their observations using pictures and words, and should participate in class discussions on the effects of varying the strength or direction of a push or pull on an object.

As students engage in these types of simple force and motion investigations, they will learn that:
• Pushes and pulls can have different strengths and directions.
• Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.
• When objects touch or collide, the object’s motion can be changed.
• The force of the push or pull will make things speed up or slow down more quickly.

To enhance students’ experiences, teachers can schedule time for students to investigate these force and motion concepts using playground equipment, such as swings, seesaws, and slides. Teachers can also use trade books and multimedia resources to enrich students’ understanding. As students participate in discussions, they should be encouraged to ask questions, share observations, and describe cause-and-effect relationships between forces (pushes and pulls) and the motion of objects.

As students come to understand the force and motion concepts outlined above, they should engage in the engineering design process as follows.

• Students are challenged to design a simple way to change the speed or direction of an object using a push or pull from another object.

• As a class, students determine what the design should be able to do (criteria). For example:
  • An object should move a second object a certain distance;
  • An object should move a second object so that the second object follows a particular path;
  • An object should change the direction of the motion of a second object; and/or
  • An object should knock down other specified objects.

• Students determine the objects that will move/be moved (balls, ramps, blocks, poker chips) and the types of structures (ramps or barriers) and materials (rubber bands, paper tubes, cardboard, foam, wooden blocks) that can be used to meet this challenge.

• Groups of students then develop a simple drawing or diagram and use given materials to build their design. Groups should be given a predetermined amount of time to draw and build their designs.

• Groups share their designs with the class, using their drawings or diagrams, and then test their designs.

• Students make and use observations to determine which of the designs worked as intended, based on the criteria determined by the class.

While engaging in this process, students should use evidence from their observations to describe how forces (pushes and pulls) cause changes in the speed or direction of an object.

In this unit of study, students learn that problem situations can be solved through engineering, and that because there is always more than one possible solution to a problem, it is useful to compare and test designs. Students will use what they have learned about the effect of pushes and pulls of varying strength and
direction on the motion of an object to determine whether a design solution works as intended. This process is outlined in greater detail in the previous section.

### Modifications

_{Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications._}

- Structure lessons around questions that are authentic, relate to students’ interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

### Research on Student Learning

Students tend to think of force as a property of an object ("an object has force," or "force is within an object") rather than as a relation between objects. In addition, students tend to distinguish between active objects and those objects that support or block or otherwise act passively. Students tend to call the active actions "force" but do not consider passive actions as "forces" (NSDL, 2015).
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.)*

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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.)*

Objects in contact exert forces on each other.

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.

Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
By the end of the 3–5 grade span, students will know that:

- Possible solutions to a problem are limited by the available materials and resources (constraints) identified. 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.
- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Interdisciplinary Connections

**English Language Arts**

In order to integrate English Language Arts into this unit, students need the opportunity to participate in shared research that will enhance their understanding of the effect of forces (pushes and pulls) on objects. This could include exploring simple books and other media or digital resources. With prompting and support, students should ask and answer questions about key details in texts in order to seek help, get information, or clarify something that they do not understand. With support from adults, students will also recall information from experiences to answer questions and clarify their thinking. With support and/or collaboration, they can use digital tools to produce and publish simple informative writing or to document their observations of the simple force and motion systems they design and build.

**Mathematics**

During this unit of study, students will make connections to Mathematics in a number of ways. Kindergartners can use simple nonstandard units to measure the distances that two different objects travel when pushed or pulled or the distances that an object travels when varying the strength of a push or a pull. If using two objects, students can compare them using a measurable attribute, such as weight, to see which object has “more of” or “less of” the attribute, and describe the effect that increased weight has on the distance that an object travels. As students conduct multiple trials with the two objects (or with a single object, varying the strength of the push or pull), they can document the distance traveled in a simple graph. Then they can analyze the data in order to describe the
cause-and-effect relationship between forces and motion of objects. As students collect and analyze data, they are learning to reason abstractly and quantitatively and use appropriate tools strategically.

| Unit Vocabulary |
|-----------------|-----------------|-----------------|-----------------|
| **Investigation One Vocabulary** | **Investigation Two Vocabulary** | **Investigation Three Vocabulary** | **Investigation Four Vocabulary** |
| compare | paper | air | collide |
| engineer | pulp | fabric | direction |
| forest | sawdust | jute | gravity |
| observation | water | land | pull |
| tree | wood | oil | push |
| wood | | recycle | ramp |
| | | | rolling |
| | | | slope |

<table>
<thead>
<tr>
<th>Educational Technology Standards</th>
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<tbody>
<tr>
<td>8.1.2.A.1, 8.1.2.A.2, 8.1.2.A.3, 8.1.2.A.5, 8.1.2.B.1, 8.1.2.C.1, 8.1.2.D.1, 8.1.2.E.1, 8.1.2.F.1</td>
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- **Technology Operations and Concepts**
  - Identify the basic features of a computer and explain how to use them effectively.
  - Create a document using a word processing application.
  - Compare the common uses of at least two different digital applications and identify the advantages and disadvantages of using each.
  - Enter information into a spreadsheet and sort the information.

- **Creativity and Innovation**
  - Illustrate and communicate original ideas and stories using multiple digital tools and resources.

- **Communication and Collaboration**
  - Engage in a variety of developmentally appropriate learning activities with students in other classes, schools, or countries using various media formats such as online collaborative tools and social media.

- **Digital Citizenship**
<table>
<thead>
<tr>
<th>Develop an understanding of ownership of print and non-print information.</th>
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<tbody>
<tr>
<td>➢ Research and Information Literacy</td>
</tr>
<tr>
<td>o Use digital tools and online resources to explore a problem or issue.</td>
</tr>
<tr>
<td>➢ Critical Thinking, Problem Solving, and Decision-Making</td>
</tr>
<tr>
<td>o Use geographic mapping tools to plan and solve problems.</td>
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</table>

## Career Ready Practices

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

<table>
<thead>
<tr>
<th>CRP1. Act as a responsible and contributing citizen and employee</th>
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<tr>
<td>Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.</td>
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<thead>
<tr>
<th>CRP2. Apply appropriate academic and technical skills.</th>
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<tbody>
<tr>
<td>Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.</td>
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<tr>
<th>CRP4. Communicate clearly and effectively and with reason.</th>
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<tr>
<td>Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others’ time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.</td>
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<tr>
<th>CRP6. Demonstrate creativity and innovation.</th>
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<tr>
<td>Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.</td>
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</tbody>
</table>
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

Appendix A: NGSS and Foundations for the Unit

Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.  
[Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.] (K-PS2-1)

Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.] (K-PS2-2)

Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.] (K-ESS3-3)

Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.] (2-PS1-2)

Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. (K-2-ETS1-2)

Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. (K-2-ETS1-3)

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td>Planning and Carrying Out Investigations</td>
<td>PS2.A: Forces and Motion</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>• With guidance, plan and conduct an investigation</td>
<td>• Pushes and pulls can have different strengths and directions. (K-PS2-1), (K-</td>
<td>• Simple tests can be designed to gather</td>
</tr>
</tbody>
</table>
### Kindergarten Unit Three: Materials and Motion

#### Analyzing and Interpreting Data
- Analyze data from tests of an object or tool to determine if it works as intended. (K-PS2-2)

#### Asking Questions and Defining Problems
- Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

#### Developing and Using Models
- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

### PS2-2
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2)

### PS2.B: Types of Interactions
- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

### PS3.C: Relationship Between Energy and Forces
- A bigger push or pull makes things speed up or slow down more quickly. *(secondary to K-PS2-1)*

### ETS1.A: Defining Engineering Problems
- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary to K-PS2-2)* (K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

### Connections to the Nature of Science

#### Scientific Investigations Use a Variety of Methods
- Scientists use different ways to study the world. (K-PS2-1)

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<table>
<thead>
<tr>
<th>English Language Arts</th>
<th>Mathematics</th>
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</table>
| With prompting and support, ask and answer questions about key details in a text.  
(K-PS2-2) **RI.K.1** | Reason abstractly and quantitatively. (K-PS2-1), ( K-2-ETS1-1), (K-2-ETS1-3) **MP.2**  
Participate in shared research and writing projects  
(e.g., explore a number of books by a favorite author and express opinions about them).  
(K-PS2-1) **W.K.7** | Model with mathematics. (K-2-ETS1-1), (K-2-ETS1-3) **MP.4**  
Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-PS2-2) **SL.K.3** | Use appropriate tools strategically. (K-2-ETS1-1), (K-2-ETS1-3) **MP.5**  
Describe measurable attributes of objects, such as length or weight.  
Describe several measurable attributes of a single object. (K-PS2-1) **K.MD.A.1**  
Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference. (K-PS2-1) **K.MD.A.2** |

**Rubric(s):** See FOSS Assessment TE page 231

**Field Trip Ideas:** Paterson Museum (fabric weaving workshop), New York Hall of Science, Liberty Science Center, Please Touch Museum