GRADE 3

Building Blocks OF SCIENCE™ | 3D

Forces and Interactions

Program Highlights and Lesson Sampler

Phenomenon-Based Investigations with Digital Support—in 30-Minute Lessons

Table of Contents
Inside this sampler, you will find:

* Next Generation Science Standards® is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of, and do not endorse, these products.

Forces and Interactions

Teacher's Guide

3rd Edition

Building Blocks
OF SCIENCE™ | 3D

Kit Materials

Material	Quantity Needed from Kit	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Bar magnet	16				■	■
Beam board	8	■	■			■
Bubble wrap			■			
Diecast car	8		■	■		■
Felt			■			
Fulcrum	8	■	■		■	■
Iron filings†					■	
Large resealable plastic bags	8	■	■	■	■	
Large styrene ball	8				■	
Large washer	8	■		■		■
Level	8	■				■
Literacy Reader: *Forces and Interactions* (below grade level)*	1	■	■	■	■	
Literacy Reader: *Forces and Interactions* (on grade level)*	1	■	■	■	■	
Petri dish	8				■	
Ring magnet	16			■	■	■
Rod	8				■	■
Roll of string	1			■		■
Sandpaper			■			
Slotted mass set with hanger	8	■				■
Small styrene ball	16				■	
Small washer	80	■	■	■	■	■
Spring scale	8		■			■
Stopwatch	8			■		
Tape measure, 150 cm	8		■	■		■

† A Safety Data Sheet (SDS) for this item is available at www.carolina.com/SDS

* The below-grade literacy reader is distinguished from the on-grade literacy reader by a yellow dot near the bottom left corner of the back cover.

Needed But Not Supplied Materials

Material	Quantity Needed	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Access to a long, smooth surface, such as a linoleum floor			■			
Assorted metallic magnetic and nonmagnetic objects (e.g., a soda can, coins, aluminum foil, metal barrettes or clips, brads, paper clips, nails, metal washers, screws, or bottle caps)	20				■	■
Chart paper or whiteboard		■				
Elevated work stations at least 1.5 m in length	8			■		
Glue stick	32	■				
Large paper clip	56	■		■		■
Markers		■				
Measuring spoon, $^{1}/_{8}$ tsp					■	
Pair of scissors	32	■	■	■	■	■
Pencil	30	■				
Quarter	1	■				
Roll of masking tape	1	■	■	■	■	■
Ruler, 30 cm	1					■
Science notebook	30	■	■	■	■	■
Small, lightweight objects that will fit on one end of the beam board (e.g., blocks, cards, paper clips, pen caps, spoons, erasers, plastic toys)	24	■				
Small paper clip	32	■				■
Textbook	8		■			■

NOTES

Unit Overview: *Forces and Interactions*

All objects experience forces. Students are likely to be familiar with forces that result in motion, like pushes or pulls, but may not know much about other forces, like magnetism or gravity, which are more abstract and require the observation of phenomena. *Forces and Interactions* focuses on Newton's three laws of motion, which form the central base of physical science concepts upon which students will develop understanding as they progress through science courses. This unit provides students opportunities to use inquiry-based, hands-on science to develop a deeper understanding of forces and the interactions that initiate, change, and stop movement. Throughout a series of five lessons, students will build upon the concepts of balanced and unbalanced forces by considering variables such as gravity, magnetism, friction, mass, and distance. Students will engage in a variety of investigations, practice engineering, and draw connections between science concepts and their real-life applications.

During a pre-unit assessment, students identify parts of a beam balance, build one, and use it to explore balanced and unbalanced forces. They then learn how balanced forces can be used to determine mass. Students are introduced to gravity, an important concept that will tie into all other lessons. Gravity helps students develop their understanding of inertia, and how forces such as gravity or friction and mass affect the movement of an object. Several investigations support these concepts and encourage students to draw connections to real-world phenomena. Later in the unit, magnetic forces are introduced as a way to cause motion. This is further explored as students identify magnetic objects, explain polarity, and define attraction and repulsion. Students are challenged to identify the poles of a ring magnet based on previous explorations of a bar magnet. In the final lesson, students review what they have learned by illustrating the unit's main concepts and engaging in a class discussion. As a final, cumulative investigation, groups choose a project and develop, test, and optimize two models. These models are evaluated for effectiveness and are shared in a class presentation.

Credit: Germanskydiver/Shutterstock.com

Next Generation Science Standards

The Building Blocks of Science unit *Forces and Interactions* integrates process skills as defined by the Next Generation Science Standards (NGSS).

Performance Expectations

- **3-PS2-1:** Plan and conduct an investigation toprovide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **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.
- **3-PS2-3:** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
- **3-PS2-4:** Define a simple design problem that can be solved by applying scientific ideas about magnets.
- **3-5-ETS1-1:** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Disciplinary Core Ideas

- **PS2.A:** Forces and Motion
- **PS2.B:** Types of Interactions
- **ETS1.A:** Defining and Delimiting Engineering Problems
- **ETS1.B:** Developing Possible Solutions

Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

- Patterns
- Cause and Effect

Important Terms Related to Science Instruction

Science and science instruction rely on specific terminology. Many scientific terms are likely to be new or unfamiliar to students. Below is a list of terms that are used throughout Building Blocks of Science units. Each is followed by a student-friendly definition to help students understand the meaning of the term in a scientific context. A brief description of how Building Blocks employs each of these scientific skills and tools is intended to help you help students model the behavior of scientists.

- **Analyze:** To examine. *Students are asked to examine (analyze) data they collect to help develop their understanding of core ideas and crosscutting concepts.*
- **Claim:** A statement. *To help students develop their understanding of concepts, they will make statements (claims) concerning various scenarios based on observations and data they have collected*.
- **Classify:** To arrange things in groups or categories. *As students investigate and collect data, they will arrange (classify) their data to look for patterns that may help to support claims that they make.*
- **Communicate:** To share information. *Students are continually asked to share experiences, questions, observations, data, and evidence (communicate) within their groups and with the class as a whole. Communication takes many forms, including discussions, the creation of models, designing solutions to problems, and formal presentations.*
- **Compare:** To note similarities and differences among things. *Like classifying, noting how things are alike and different (comparing) is another skill that students will use to analyze their data and look for patterns, cause and effect relationships, and other crosscutting concepts.*
- **Conclude:** To arrive at an opinion by reasoning. *The scientific practices of conducting investigations, collecting and analyzing evidence, and sharing and discussing information lead students to form opinions based on reasoning (to conclude). The conclusions that students develop during the unit will help you assess their understanding of the unit's core ideas.*
- **Evaluate:** To form an idea based on evidence. *Throughout each unit, students will look at (evaluate) the observations and data they collect and discuss their conclusions with classmates in order to form ideas about concepts based on evidence.*
- **Evidence:** Information to show whether something is true or valid. *Students will use the observations and data (evidence) they collect to support claims they make as being valid or true.*
- **Explain:** To describe in detail. *Throughout investigations, students will analyze the data they collect, make claims supported by evidence, and share their information with one another to make sense of (explain) core ideas and phenomena.*
- **Investigate:** To use a standard process to discover facts or information. *Students will carry out standard processes (investigate), sometimes developing those processes themselves, to discover facts or information related to scientific ideas.*
- **Model:** A representation of an object or idea. *Using a representation of an object or idea (a model) helps student scientists communicate and evaluate ideas regarding phenomena. Students will develop many types of models during a unit, including drawings, physical models, diagrams, graphs, and mathematical representations.*

- **Phenomena:** Occurrences or events that can be observed and cause one to wonder and ask questions. *Presenting occurrences or events (phenomena) related to the science concepts being studied engages students through real-world events and ensures common experiences for all students. Presenting phenomena also allows students to develop their own questions and take ownership of their learning.*

- **Predict:** To develop anticipated results of an event based on prior experience or knowledge. *Students are asked to anticipate (predict) the results of events based on experience and data from prior events.*

- **Reasoning:** Thinking about something in a logical way. *Students are asked to make claims, support them with evidence, and explain their claims in a logical fashion (with reasoning). Making claims supported with evidence and reasoning is scientific, or evidence-based, argumentation.*

- **Record:** To write down. *During investigations, students will keep track of their observations (record) by drawing or writing in their science notebooks or on student investigation sheets.*

- **Variable:** A factor that is able to be changed. *As students conduct investigations, they will consider which factors can be changed or manipulated (variables) to test something during the investigation.*

The 5E Instructional Model

Building Blocks of Science uses a constructivist approach to learning by encouraging students to build upon existing ideas using the 5Es. This instructional model cycles through five phases:

- **Engage:** Students draw upon prior knowledge to make connections to a new concept or topic.
- **Explore:** Students are provided with an activity related to a concept or topic and are encouraged to make claims and observations, collect evidence, and ask questions.
- **Explain:** Students use observations and discussion to construct an explanation for a concept or topic they are studying.
- **Elaborate:** Students must draw upon their experiences and apply their knowledge to a new situation in order to demonstrate understanding.
- **Evaluate:** Students assess their knowledge and review what they have learned.

In each Building Blocks of Science unit, students begin with an engaging pre-assessment activity, which allows the teacher to gauge levels of previous knowledge. The following lessons cycle through the explore, explain, and elaborate phases, and then in the final lesson, students are evaluated using project-based and summative assessments.

Incorporating Phenomena

Building Blocks of Science uses phenomena, or observable occurrences, to encourage students to develop questions that will lead to deeper understanding of the core ideas investigated in each unit and to support inquiry-based learning. Each unit includes both an anchoring phenomenon and lesson-specific investigative phenomena.

The unit's anchoring phenomenon, introduced to students in the first lesson, serves as the main focus of the unit. The anchoring phenomenon is introduced through a descriptive narrative in the Teacher's Guide and supported visually by a short online video. This visual teaser of the anchoring phenomenon piques students' interest and helps them to think more deeply and to develop questions. Viewing the video again at the end of the unit prompts students to make connections between the anchoring phenomenon and its applications beyond the scope of the unit's investigations.

An investigative phenomenon is presented to students at the beginning of each lesson to encourage them to develop additional questions. At the end of each lesson, the class revisits its questions and addresses them based on the evidence they collected during the lesson investigations, making connections to the lesson's investigative phenomenon.

As students begin to develop a deeper understanding of the unit's core ideas, they begin to make sense of the phenomena introduced throughout the unit. Students draw connections between what they have learned and how it applies to the world around them. In the last lesson, students engage in a performance task in which they are challenged to synthesize their knowledge to make connections to the unit's anchoring phenomenon. Students may be asked to build a model or design a solution to a problem. When communicating their designs and findings to their classmates, students explain their reasoning using evidence-based claims and answer questions during their presentation.

Each unit's literacy and digital components provide examples of connections between a concept and a phenomenon and ask students to make their own. Teachers are encouraged to support these connections by selecting related articles and videos or by engaging the class in discussion. Teacher Tips within the Teacher's Guide suggest other opportunities to identify related phenomena.

Anchoring phenomenon videos kick off each unit

The Engineering Cycle

Building Blocks of Science incorporates an engineering design process to support the engineering, technology, and application of science (ETS) core idea outlined in the National Research Council's "A Framework for K–12 Science Education" (NRC, 2012, pp. 201–202). This ETS core idea has been brought into action through the NGSS ETS performance expectations, which allow students to practice systematic problem solving as they apply scientific knowledge they have acquired.

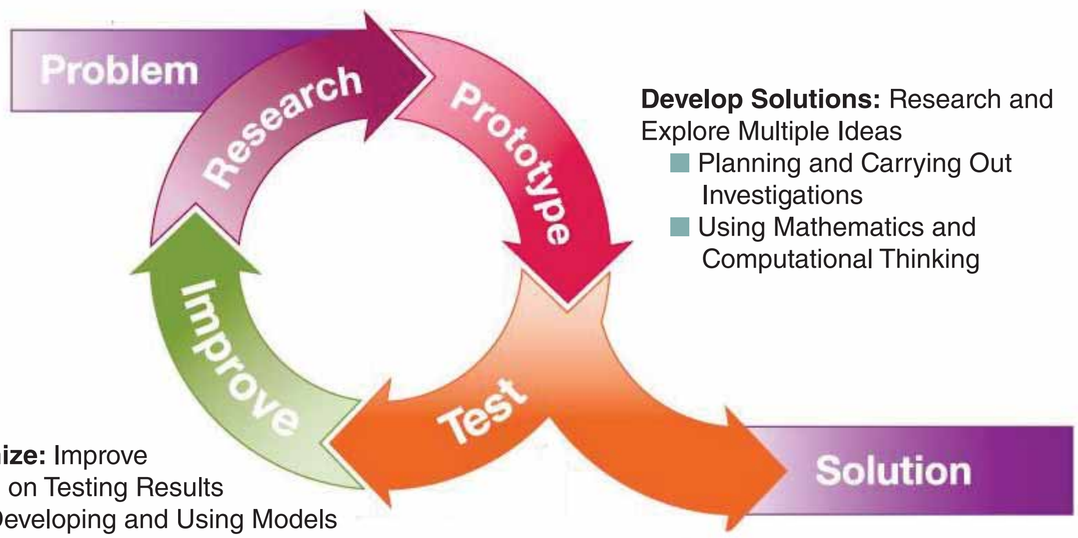
Through scientific engineering and design, students apply what they have learned to creatively solve real-world problems. This 21st-century skill encourages students to collaborate and exposes them to the idea that one problem can have multiple solutions.

An engineering design process can be thought of in three phases: defining a problem, developing solutions, and optimizing the design. Each phase can be correlated with NGSS Science and Engineering Practices as depicted in the graphic below.

Engineering Design Process

Define Problem: Identify Constraints and Criteria for Success

- Asking Questions and Defining Problems
- Obtaining and Evaluating Information



Develop Solutions: Research and Explore Multiple Ideas

- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking

Optimize: Improve Based on Testing Results

- Developing and Using Models
- Analyzing and Interpreting Data

In each Building Blocks of Science unit, students employ this engineering cycle to assess their knowledge and build problem-solving skills. Depending on the activity, students may be creating a model, developing an experiment, or redesigning an existing product. To increase student engagement, relate the engineering process to a task, a phenomenon, or a career.

Sensemaking: Developing Claims Supported with Evidence and Reasoning

Scientific argumentation, or evidence-based argumentation, is defined as making scientific explanations (claims) using empirical data (evidence) to justify an argument (reasoning). Scientists use this type of argumentation to make sense of phenomena and refine their ideas, explanations, and experimental designs. In the classroom, students should be introduced to scientific argumentation to guide them in sensemaking, or building an understanding of phenomena based on evidence gained through observations, investigations, and data analysis. Through sensemaking, students refine and revise their understanding as new evidence is acquired and information is shared through class discussions.

Building Blocks of Science units offer multiple opportunities for students to make sense of scientific concepts by developing claims and supporting their claims with evidence and reasoning. At the start of an investigation, students are presented with a question related to a scientific concept. To make sense of a phenomenon or concept, students must draw upon their previous knowledge and experiences to develop a statement or conclusion that answers the question. To support that claim, students must provide relevant and specific data as evidence. This data may come from previous investigations, inference clues, texts, or class discussions. Students may even reference personal experience. Reasoning provides justification for why the selected evidence supports the claim. Relevant scientific principles should be incorporated into this reasoning. After the investigation, students should revisit their initial claims and determine if they are supported by newly gathered evidence. If the available evidence does not support students' initial claims, students should identify misunderstandings and present a claim that is supported.

To support students who struggle with scientific argumentation, ask them to use sentence frames such as "I think _____ because ______" to help with sensemaking. Explain that the first blank is the claim and the second blank is the evidence and reasoning.

Science Notebooks

Science notebooks are an integral part of the process of learning science because they provide a location for students to record their ideas, questions, predictions, observations, and data throughout the unit. The science notebook is used for notes, Tell Me More responses, diagrams, and outlines. Student investigation sheets can be glued, taped, or stapled into the science notebook as well.

Spiral notebooks are recommended and can be purchased inexpensively. If you choose to pre-assemble notebooks, consider including blank sheets of centimeter graph paper and plain paper for writing and drawing. It is recommended to create tabs for each lesson and to have students date each entry.

NOTE: Student investigation sheets use a specific numbering sequence to make it easier for students and teachers to identify them. The first number calls out the lesson, and the letter references the investigation. For example, Student Investigation Sheet 1A supports Investigation A of Lesson 1. If there are multiple student investigation sheets in one investigation, a second number will indicate the order of use (Student Investigation Sheet 2A.1, 2A.2, etc.).

Take-Home Science Activities

Take-Home Science activities are included in each unit and are called out within the related lesson. These activities reflect the science concepts and vocabulary that students are learning about and extend that learning to the home.

A reproducible letter explains how Take-Home Science activities work. Topic-specific activity sheets include directions for the parent, simple background information, and a space for the student to record observations or data. It is recommended that students share their findings and compare experiences as a class after completing the activity. Take-Home Science resources are found with the student investigation sheets at the end of the lesson in which they are assigned.

Assessment

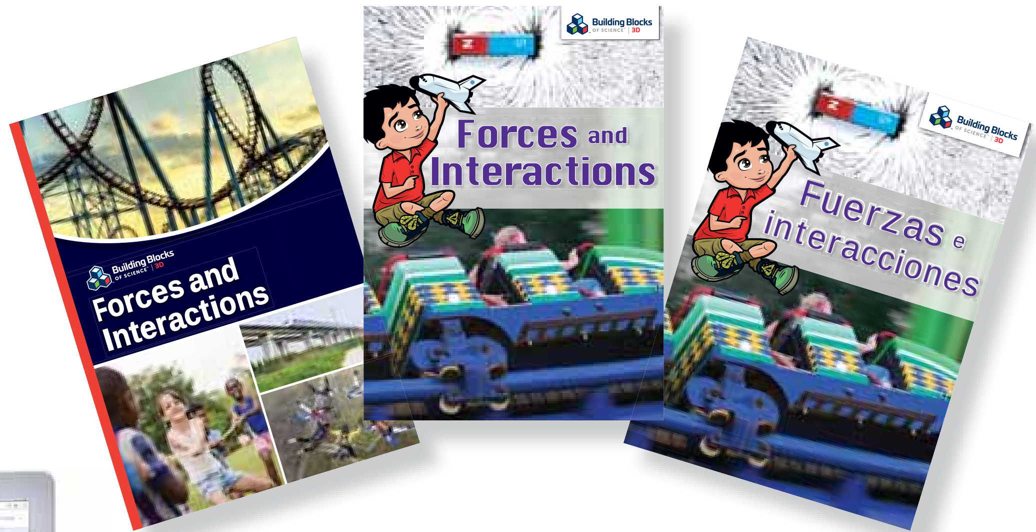
Building Blocks of Science units provide assessment opportunities that correspond to specific lesson objectives, general science process skills, communication skills, and a student's ability to apply the concepts and ideas presented in the unit to new situations. The Teacher's Guide includes strategies for both formative and summative assessment. Each unit includes:

- **Pre-Unit Assessment and Post-Unit Assessment Opportunities:** The pre-unit assessment asks students to draw upon previous knowledge, allowing you to gauge their levels of understanding. The post-unit assessment touches upon the topics and concepts from the entire unit and evaluates students' learning. It is a beneficial practice to ask students to compare the pre-unit assessment and post-unit assessment activities to evaluate growth.
- **Formative Assessment Strategies:** At the end of each lesson, specific strategies are listed for each investigation. These include ways to utilize Student Investigation Sheets and Tell Me More questions as assessment tools. In lower grades, an Assessment Observation Sheet lists things to look for as you work with small groups of students.
- **Literacy and Digital Components:** These resources can be assigned to differentiate assignments and to assess student progress as needed.
- **General Rubric:** Appendix A includes a rubric that provides an expected progression of skills and understanding of science content. You can use these guidelines to assess students throughout the course of the unit.
- **Summative Assessment:** This unit-specific, cumulative assessment allows students to demonstrate their understanding of content presented by responding to questions in a variety of formats. Each question is aligned to performance expectations and provides insight on students' understanding of the concepts addressed. An answer key is provided, as well as a chart that indicates the performance expectation addressed by each question and lessons to revisit if remediation is required.

Additionally, there is a second end-of-unit assessment accessible only online. This digital summative assessment is **scenario-based** and touches upon all the standards from the unit. It includes both close-ended and open-ended questions.

Building Blocks of Science 3D—The Total Package

Phenomenon-Based Investigations with Digital Support—in 30-Minute Lessons

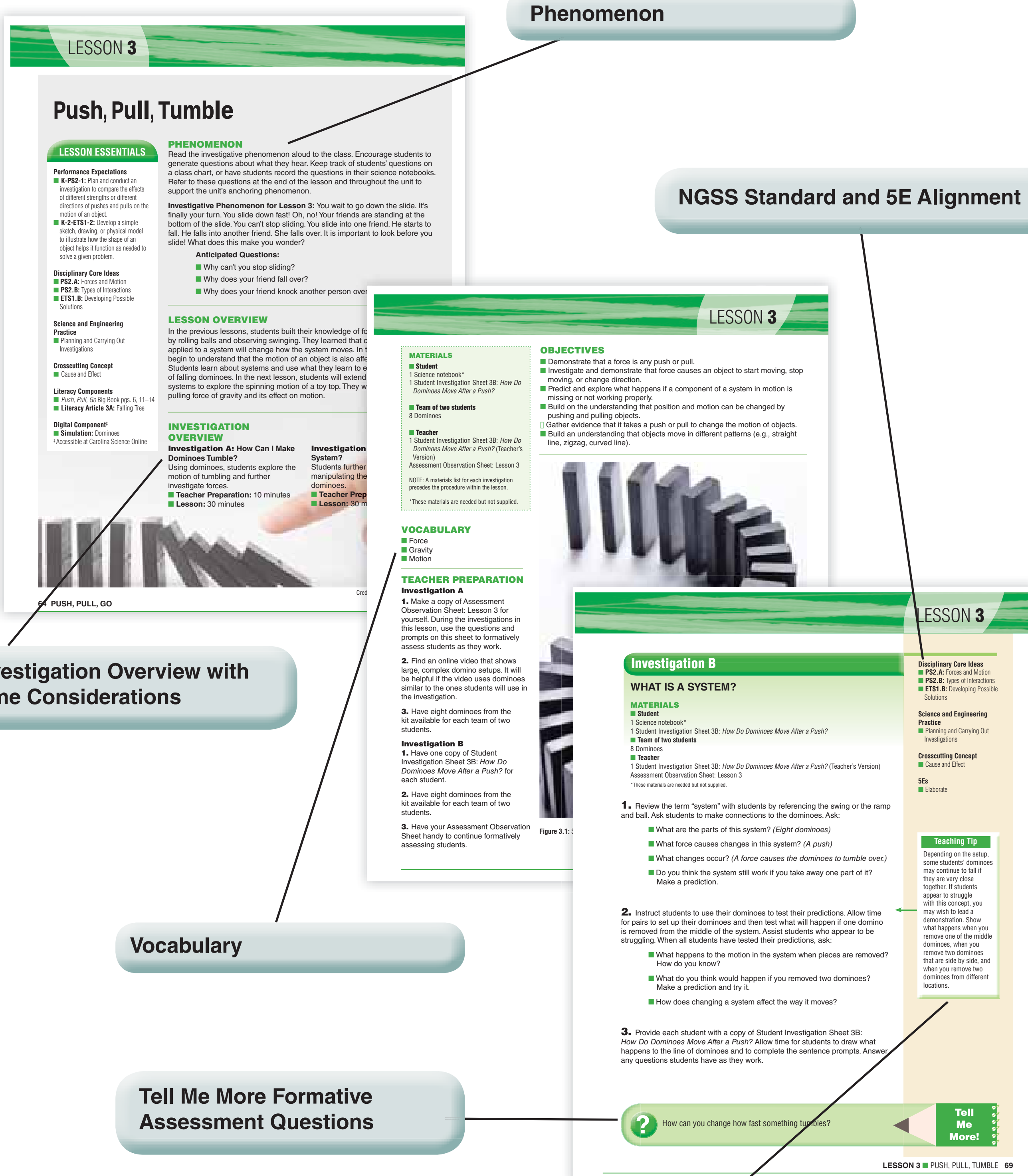


Hands-on materials are always included—not an extra purchase

Navigating the Teacher's Guide

Phenomenon

NGSS Standard and 5E Alignment



Investigation Overview with Time Considerations

Vocabulary

Tell Me More Formative Assessment Questions

Teacher Tips and Differentiation Strategies

Extensions

LESSON **3**

EXTENSIONS

Action Attraction
Challenge students to explore what might make the dominoes fall more slowly or more quickly. You might prompt students by asking:

- Does spacing make a difference in how a line of dominoes topples over?
- How might you test this question?
- Make a prediction and then try your ideas.

Domino Rally Events
Do a quick Internet search for videos that show domino challenges that people have set up. Share these videos with students, and encourage them to work together in small groups with all 96 dominoes to see how many dominoes they can set up to tumble with one push.

Credit: Africa Studio/Shutterstock.com

Counting and Setting Up Sets
Challenge pairs of students in a learning center to set up a line of dominoes that not only will fall down with one push but also is set up in sets of two or five. Have students offset the line of dominoes so that before the line is sent tumbling, they can identify and count the sets of two, three, or five.

ASSESSMENT STRATEGIES

1. Investigation A

- Use students' responses to the Tell Me More question to assess their understanding of domino motion. If students do not seem to understand this concept, you may wish to provide supplemental examples of motion and force.

2. Investigation B

- Use Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* to determine how well students understand force and motion using dominoes. Look for use of appropriate vocabulary and drawings that demonstrate motion.
- Use students' responses to the Tell Me More question to evaluate their understanding of forces. Students should recognize that adding force will increase the speed at which an object tumbles.

3. Refer to the Assessment Observation Sheet where you recorded observations during this lesson to formatively assess your class, and adjust instruction as needed.

4. Refer to the General Rubric in Appendix A to assess individual progress as needed.

Additional Features

- Lesson Overview Charts
- Guide to Instructional Scaffolding
- Teacher Preparation
- Background Information
- NGSS Standards by Lesson
- Literacy and Digital Components
- Summative Assessment

Assessment Strategies

Literacy Article 3A

Name: ____________ Date: ________

Falling Tree

You saw a tree in the forest. It was tall. It was wide. It was huge!

It rained hard. The wind blew.

The tree tumbled over! The tree fell onto smaller trees.

They had thin trunks. The smaller trees tumbled, too. The smaller trees fell on bushes. The bushes tumbled.

The rain stops. The Sun comes out. Birds start to sing.

Credit: Patrycja

Literacy Articles

Take-Home Science Activities

Student Investigation Sheet 3B: How Do Domino

Name: ____________ Da

This is a line that moves.

Dominoes ____________.

A push ____________.

 Student Investigation Sheet 3B

Student Investigation Sheets

Take-Home Science

Dear Family,

Our class is beginning an inquiry science unit. Inquiry science is all about questions, active explorations, drawing, writing, and recording what you see and do to build an understanding of science. Young children are natural scientists. Scientists question everything. Once scientists answer one question, they move without blinking to the next question.

Take-Home Science is an exciting part of our program because it's one way we can better connect home and school. With everyone working together, we can reinforce the science concepts that your student is exploring in the classroom. Here's how Take-Home Science works.

Your student will bring home an investigation sheet that explains an activity related to the science unit the class is studying. The activity is designed so that everyone in the household—younger and older children alike—can work together to learn about science.

A section of the investigation sheet explains the science words and ideas that will be explored during the activity. These science words and ideas are not new to your student, because the activity follows a lesson in which those same concepts were explored.

The activities are simple and can be completed within 20 minutes using items normally found in the home. A section of the investigation sheet is for your student to complete and bring back to school. In class, your student will have the opportunity to share his or her experiences and results with other students.

The activities are intended to be quick, informal, and fun. Enjoy!

GO EXPLORING!

Credit: Cathy Keifer /Shutterstock

 Lesson 5 Take-Home Science Letter

Forces and Interactions

Unit Overview

All objects experience forces. Students are likely to be familiar with forces that result in motion, like pushes or pulls, but may not know much about other forces, like magnetism or gravity, which are more abstract and require the observation of phenomena. *Forces and Interactions* focuses on Newton's three laws of motion, which form the central base of physical science concepts upon which students will develop understanding as they progress through science courses. This unit provides students opportunities to use inquiry-based, hands-on science to develop a deeper understanding of forces and the interactions that initiate, change, and stop movement. Throughout a series of five lessons, students will build upon the concepts of balanced and unbalanced forces by considering variables such as gravity, magnetism, friction, mass, and distance. Students will engage in a variety of investigations, practice engineering, and draw connections between science concepts and their real-life applications.

Unit Anchoring Phenomenon

All motion relies on the interactions of forces. Depending on the forces at work on an object, it may start, stop, change direction, or change speed. The mass of the object and the strength of the forces at work affect the resulting motion of the object. The anchoring phenomenon for *Forces and Interactions* is recognizing the interactions between forces at an amusement park.

	LESSON 1	LESSON 2
INVESTIGATIVE PHENOMENA	The Giant Drop is a roller coaster that takes the car far up a track in the air, where it pauses for a long time. Suddenly, the car is released, and it moves to the bottom of the track at a very high rate of speed. You decide to ride the Giant Drop with your friend. You choose seats next to each other, but before the operator starts the ride, he asks your friend to move over to the other side of the ride to create balance. He says that the ride is not safe if it is not balanced. What does this make you wonder?	A Fun Slide is three slides side by side that allows friends to race. One of the slides has been freshly oiled. On the count of three, three friends begin to slide. One friend sits on a mat and slides all the way down. One friend does not use a mat and gets stuck halfway down the slide. The third friend uses a mat, but she moves faster than the other two friends and wins the race! What does this make you wonder?
OBJECTIVES	■ Use a beam balance model to investigate balanced forces. ■ Determine the relative mass of an object using a beam balance. ■ Define "force," and draw connections to the forces acting upon an object in motion and an object at rest. ■ Explain how the pull of gravity can result in balanced forces.	■ Use models to explain the law of inertia. ■ Explain how forces are required to change the motion of objects. ■ Identify the cause-and-effect relationship between forces and movement. ■ Predict how different textures affect friction.
SCAFFOLDING Students should know:	↓ All objects experience forces, whether they are moving or still. ↓ Gravity is a pulling force that all objects experience. ↓ The forces acting on an object are balanced when the object is still. ↓ The relative mass of an object can be determined using a beam balance. ↓ Expressions can be used to describe the relative mass of an object.	↓ Forces are unbalanced when one force is greater than others. ↓ Unbalanced forces result in movement. ↓ Inertia is an object's resistance to a change in motion. ↓ Objects at rest will stay at rest and objects in motion will stay in motion unless another force acts on them. ↓ The amount of force applied to an object will affect its motion, specifically its speed and the distance it travels. ↓ Friction is a force that causes objects to slow down. ↓ Friction is related to the texture of a surface or an object.

Concepts build from one lesson to the next

LESSON 3	LESSON 4	LESSON 5
Four friends wait to ride a roller coaster. They notice a sign that has height and weight requirements for riders. Before the friends get on the ride, the conductor asks if they want an extra push at the top of the hill. During the ride, the car seems to slow down whenever the track makes a turn. What does this make you wonder?	Some types of roller coasters use an electromagnetic track. With a switch, the ride operator is able to use electricity to reverse the magnetic poles on the track. This can cause the roller coaster to begin moving or stop moving. What does this make you wonder?	Amusement parks have games for which you can win prizes. However, these games are designed to be very difficult to win. In one game, you must use a water shooter to knock over a target. Some people are suspicious that the target has been secured to its base with a magnet. What does this make you wonder?
■ Use a model to determine how the strength of a force affects an object's motion. ■ Use a model to determine how an object's mass affects its ability to overcome inertia. ■ Observe a magnetic force and investigate how its strength can be changed.	■ Make connections between magnetism and the material an object is made from. ■ Identify attractive and repulsive charges. ■ Recognize attractive magnetic forces as pulls and repulsive magnetic forces as pushes. ■ Plan an investigation to prove that magnetic fields can differ based on the shape of the magnet. ■ Use a model to demonstrate how electric forces behave similarly to magnetic forces.	■ Reinforce previous learning and draw connections between forces, including gravity, magnetism, and electricity. ■ Design an efficient model of magnetism. ■ Evaluate a model to identify patterns related to forces and their interactions. ■ Evaluate learning from throughout the unit about forces and interactions, and compare that knowledge to initial ideas from the beginning of the unit.
↓ The strength of a force will affect the resulting motion of an object. ↓ The speed at which an object travels and the distance that object moves are dependent on the strength of the force applied to the object. ↓ A strong force is needed to change the motion of an object with a great mass. ↓ An object's inertia is affected by its mass. ↓ Magnetic force is a pulling force. ↓ The strength of a magnetic force can be changed by adding more magnets to a system.	↓ Not all metals are magnetic. ↓ Iron is a type of metal that is magnetic. ↓ Magnets can have pulling and pushing forces, which relate to the terms "attract" and "repel." ↓ Magnets have poles. Like poles repel and different poles attract. ↓ All magnets have a magnetic field, which is the space in which magnetic objects can be attracted. ↓ Magnetic fields vary based on the shape of the magnet. ↓ Electric forces act similarly to magnetic forces and have poles, which are referred to as "charges." ↓ Some materials can build a strong electric charge when they are rubbed.	↓ A force can be a push or a pull. Gravity, friction, magnetism, and electric charges are different types of forces. ↓ Forces can be balanced or unbalanced and have different strengths. ↓ An object's inertia is dependent on its mass and on the strength of the applied force. ↓ Applied forces can make an object change speed or direction. Without an applied force, objects at rest stay at rest and objects in motion stay in motion.

NGSS correlations by lesson

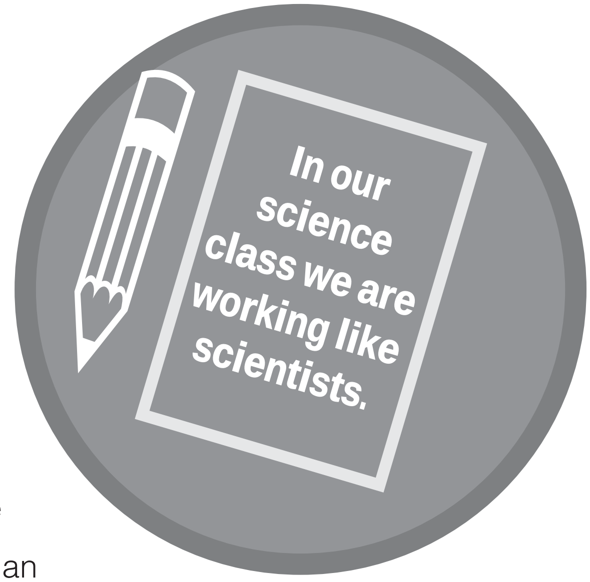
Lesson 3: Changes in Motion

Investigation Overview	Standards	Resources
Investigation A: How Does Force Affect the Motion of an Object? **5Es:** Explore, Explain Students increase the amount of force pulling on a car and observe the effects on its speed. ■ **Teacher Preparation:** 15 minutes ■ **Lesson:** 30 minutes **Tell Me More!** The force of gravity pulls objects closer to Earth. Is there a way we can increase the speed at which an object falls? **Investigation B: How Does Mass Affect the Motion of an Object?** **5Es:** Explain, Explore, Elaborate Students adjust the mass of a car and observe the effects on the distance it travels. ■ **Teacher Preparation:** 5 minutes ■ **Lesson:** 30 minutes **Tell Me More!** Explain why a larger washer has more inertia. How will this affect the magnetic force? **Investigation C: How Can I Increase Magnetic Forces?** **5Es:** Explore, Explain Students are introduced to magnetic forces by attracting a washer using one or two magnets. ■ **Teacher Preparation:** 5 minutes ■ **Lesson:** 30 minutes **Tell Me More!** Imagine you had a bigger magnet. Do you think a bigger magnet would increase or decrease the strength of the magnetic force? Explain your answer.	**Next Generation Science Standards Performance Expectation** ■ **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. **Disciplinary Core Ideas** ■ **PS2.A:** Forces and Motion ■ **PS2.B:** Types of Interactions **Science and Engineering Practices** ■ Asking Questions and Defining Problems ■ Developing and Using Models ■ Constructing Explanations and Designing Solutions **Crosscutting Concepts** ■ Patterns ■ Cause and Effect **Language Arts and Math Standards** **Language Arts** ■ **L.3.6:** Vocabulary Acquisition and Use ■ **RI.3.3:** Key Ideas and Details ■ **SL.3.1:** Comprehension and Collaboration ■ **W.3.2:** Text Type and Purpose **Math** ■ **3.NBT.A.1:** Use place value understanding and properties of operations to perform multi-digit arithmetic. ■ **3.NBT.A.2:** Use place value understanding and properties of operations to perform multi-digit arithmetic. ■ **3.MD.B.3:** Represent and interpret data.	**Student Investigation Sheets** ■ Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* ■ Student Investigation Sheet 3B: *Can Mass Change Motion?* ■ Student Investigation Sheet 3C: *Can I Increase Magnetic Force?* **Literacy Components** ■ *Forces and Interactions* Literacy Reader, pgs. 2–3, 10–11 ■ Literacy Article 3B: Clowning Around **Digital Component** ■ Simulation: Force, Motion, Speed **Vocabulary** ■ Acceleration ■ Decrease ■ Distance ■ Increase ■ Load ■ Speed ■ Strength

30-minute investigations fit into your busy day

Integrated ELA and math

Safety Contract



In science class, I will:

- Listen to directions
- Complete each step of the experiment
- Look, feel, smell, and listen but never taste
- Wait to begin until my teacher tells me
- Wear safety goggles when my teacher tells me
- Ask my teacher to approve any experiment I plan on my own or with classmates
- Keep my hands away from my mouth and eyes as I work
- Tie back long hair
- Tuck in loose clothing
- Keep my workstation neat
- Put away materials after use
- Follow all safety rules

I have read this contract and will follow these safety rules in science class.

Student's signature ______________________________

Date ______________________________

I have read this safety contract and understand what is expected of my child during science class.

Parent/Guardian's signature ______________________________

Date ______________________________

Note to Parent/Guardian:
Science materials and activities are chosen for safety and age appropriateness.

All lessons are anchored in phenomena

Changes in Motion

LESSON ESSENTIALS

Performance Expectation
- **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.

Disciplinary Core Ideas
- **PS2.A:** Forces and Motion
- **PS2.B:** Types of Interactions

Science and Engineering Practices
- Asking Questions and Defining Problems
- Developing and Using Models
- Constructing Explanations and Designing Solutions

Crosscutting Concepts
- Patterns
- Cause and Effect

Literacy Components
- *Forces and Interactions* Literacy Reader, pgs. 2–3, 10–11
- **Literacy Article 3B:** Clowning Around

Digital Component‡
- **Simulation:** Force, Motion, Speed

‡ Accessible at Carolina Science Online

OBJECTIVES

- Use a model to determine how the strength of a force affects an object's motion.
- Use a model to determine how an object's mass affects its ability to overcome inertia.
- Observe a magnetic force and investigate how its strength can be changed.

PHENOMENON

Read the investigative phenomenon aloud to the class. Encourage students to generate questions about what they hear. Keep track of students' questions on a class chart, or have students record the questions in their science notebooks. Refer to these questions at the end of the lesson and throughout the unit to support the unit's anchoring phenomenon.

Investigative Phenomenon for Lesson 3: Four friends wait to ride a roller coaster. They notice a sign that has height and weight requirements for riders. Before the friends get on the ride, the conductor asks if they want an extra push at the top of the hill. During the ride, the car seems to slow down whenever the track makes a turn. What does this make you wonder?

Anticipated Questions:
- How will an extra push affect the roller coaster?
- Why do roller coasters have height and weight requirements for riders?
- Why does the roller coaster slow down when it turns?

LESSON OVERVIEW

In the previous lessons, students considered balanced and unbalanced forces by investigating concepts related to inertia, friction, and gravity. In this lesson, students apply unbalanced forces to an object and observe the resulting motion. By securing small masses to the end of a string attached to a car, students observe that the force required to set the car in motion increases with the amount of mass added to the car. Force and weight also affect the speed of the car. Students learn that adding a load to the car will require more force to be applied to set the car in motion and will slow the car's movement. Magnets are also explored when students learn that the strength of a magnetic force can increase when more magnets are added to a system. These concepts are further examined in the next lesson, in which students determine which objects are magnetic and explore attraction and repulsion. Magnetism is an important concept as students approach the final investigation, in which they will design a model.

INVESTIGATION OVERVIEW

Investigation A: How Does Force Affect the Motion of an Object?
Students increase the amount of force pulling on a car and observe the effects on its speed.
- **Teacher Preparation:** 15 minutes
- **Lesson:** 30 minutes

Investigation B: How Does Mass Affect the Motion of an Object?
Students adjust the mass of the car and observe the effects on the distance it travels.
- **Teacher Preparation:** 5 minutes
- **Lesson:** 30 minutes

Investigation C: How Can I Increase Magnetic Forces?
Students are introduced to magnetic forces by attracting a washer using one or two magnets.
- **Teacher Preparation:** 5 minutes
- **Lesson:** 30 minutes

Credit: Germanskydiver/Shutterstock.com

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?*
1 Student Investigation Sheet 3B: *Can Mass Change Motion?*
1 Student Investigation Sheet 3C: *Can I Increase Magnetic Force?*

Team of four students

1 Diecast car
6 Large paper clips*
1 Large washer
8 Pieces of masking tape, 2.5 cm*
2 Pieces of masking tape, 5 cm*
1 Piece of string, 1.5 m
2 Ring magnets
1 S-shaped paper clip*
6 Small washers
1 Stopwatch
1 Tape measure, 150 cm

Class

8 Elevated workstations at least 1.5 m in length*

Teacher

1 Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* (Teacher's Version)
1 Student Investigation Sheet 3B: *Can Mass Change Motion?* (Teacher's Version)
8 Large paper clips*
8 Large resealable plastic bags
1 Pair of scissors*
1 Roll of masking tape*
1 Roll of string

NOTE: A materials list for each investigation precedes the procedure within the lesson.

*These materials are needed but not supplied.

VOCABULARY

- Acceleration
- Decrease
- Distance
- Increase
- Load
- Speed
- Strength

TEACHER PREPARATION

Investigation A

1. Make one copy of Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* for each student.

2. Prepare a large resealable plastic bag of materials for each group of four students. Place one stopwatch, one tape measure, and one car in each bag.

3. For each group of four students, cut one 1.5-meter piece of string from the roll provided in the kit. Make a loop at one end of each piece. (See Figure 3.1 as needed for guidance in prepping the string.) Place one prepared string in each group's bag of materials.

NOTE: These pieces of string will be reused in Investigation B.

4. Obtain 56 large paper clips. Unfold eight of the paper clips to make an S shape, so that one end of the paper clip can hook onto the loop in the string and the other end can hold paper-clip masses during the investigation. (See Figure 3.1.) Place one S-shaped paper clip and six unbent paper clips in each group's bag of materials.

NOTE: These paper clips will be reused in Investigation B.

5. Cut eight 2.5-cm pieces of masking tape and one 5-cm piece of masking tape for each group. Attach these to the outside of each bag.

6. The class will need eight elevated workstations at least 1.5 meters long. Make arrangements in advance if your classroom configuration does not include these.

Investigation B

1. Make one copy of Student Investigation Sheet 3B: *Can Mass Change Motion?* for each student.

2. Prepare a large resealable plastic bag of materials for each group of four students. Place six small washers, two ring magnets, one large washer, one tape measure, one diecast car, and one stopwatch in each bag. Be sure each bag includes six large paper clips, one S-shaped paper clip, and one looped string from Investigation A.

3. Cut one 5-cm piece of masking tape for each group. Stick this to the outside of each bag.

4. The class will need eight elevated workstations at least 1.5 meters long. Make arrangements in advance if your classroom configuration does not include these.

Investigation C

1. Make one copy of Student Investigation Sheet 3C: *Can I Increase Magnetic Force?* for each student.

2. Have two ring magnets and one small washer from the kit available for each group of four students.

Just-in-time background information

BACKGROUND INFORMATION

Acceleration is any change in the **speed** or direction of a moving object. Students will focus primarily on acceleration as a change in speed because directional changes often relate to vectors. Newton's second law of motion focuses on this concept, stating that for a given amount of force, the acceleration of an object will **decrease** as the mass **increases**. In other words, the heavier an object is, the harder it is to accelerate it. However, acceleration also depends on the amount of force applied. If mass is consistent, the acceleration will increase if the force increases.

Consider this example: Although it takes force to move a truck, the size of the force needed to accelerate the truck depends on how heavy its **load** is. It takes less force to accelerate the truck when it has no load in the bed than it takes to accelerate the truck when the bed is full.

Students will also consider distance in this lesson. **Distance** is the length traveled by a moving object. Speed measures how fast an object can cover a distance. Speed is calculated by dividing the distance traveled by the time it took to travel that distance. Speed and distance should be familiar concepts to students, but it is important they can relate them to forces. Depending on the amount of force applied to an object, the speed and distance it travels will vary. Typically, the more force applied to an object, the greater distance it will travel at a high speed; however, like acceleration, this is dependent on the mass of the object.

3-dimensional learning

Investigation A

HOW DOES FORCE AFFECT THE MOTION OF AN OBJECT?

MATERIALS

Student
- 1 Science notebook*
- 1 Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?*

Team of four students
- 1 Diecast car
- 6 Large paper clips*
- 8 Pieces of masking tape, 2.5 cm*
- 1 Piece of masking tape, 5 cm*
- 1 Piece of string, 1.5 m
- 1 S-shaped paper clip*
- 1 Stopwatch
- 1 Tape measure, 150 cm

Class
- 8 Elevated workstations at least 1.5 m in length*

Teacher
- 1 Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* (Teacher's Version)
- 8 Large paper clips*
- 8 Large plastic resealable bags
- 1 Pair of scissors*
- 1 Roll of masking tape*
- 1 Roll of string

*These materials are needed but not supplied.

1. Review the concepts the class has investigated so far by asking students to refer to the two-column charts in their science notebooks about forces, gravity, inertia, and friction. Allow students to ask questions related to these concepts, and facilitate a class discussion.

2. Present students with a scenario involving unbalanced forces, such as kicking a ball, pushing a heavy box, or playing tug-of-war. Ask:

- How are unbalanced forces created? What evidence proves an unbalanced force was applied? *(Applying a push or a pull to make an object experience unbalanced forces results in movement or a change in speed or direction.)*

3. Ask students to think about how the **strength** of a force can affect the way an object moves. Encourage students to use examples to explain this relationship. After some time, allow students to share their ideas. Look for an understanding that a stronger force will cause an object to move farther and faster.

4. Distribute a bag of materials to each group of four students. Provide one copy of Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* to each student. Instruct students to write a prediction in Part A about how force will affect motion and to provide evidence and reasoning for that claim.

Disciplinary Core Ideas
- **PS2.A:** Forces and Motion
- **PS2.B:** Types of Interactions

Science and Engineering Practices
- Asking Questions and Defining Problems
- Developing and Using Models

Crosscutting Concepts
- Patterns
- Cause and Effect

5Es
- Explore
- Explain

Literacy Component
- *Forces and Interactions* Literacy Reader, pgs. 2–3

Digital Component
- **Simulation:** Force, Motion, Speed

Teaching Tip

If students struggle to develop a prediction, have them use the prompt "I think _____ because _______."

The setup for this investigation might be confusing to some students. It might help to demonstrate how to set up the experiment. To do so, follow the directions on Student Investigation Sheet 3A and use Figure 3.1 for reference.

5. Review the directions in Part B of the Investigation Sheet 3A, and direct groups to remove the equipment from their bags of materials. Direct students' attention to the diecast car, and ask them to test their prediction by pushing the car harder or more gently on the surface of their desk. After some time, ask:

- Was your prediction supported? *(Answers will vary.)*
- Using your hand to push the car is not a good way to determine how the strength of the force affects the movement of the car. Why not? *(Answers will vary. Guide students to recognize that all students will push the car with a different amount of force.)*

6. Guide groups to set up for the experiment by attaching the string to the bottom of the car using the 5-cm piece of masking tape from the outside of their bag of materials. Make sure the straight end of the string is on the bottom of the car and the looped end is extended out in front of the car. Direct students to wrap the tape around the body of the car rather than the car's length to secure the string. Once the string is in place, groups should hook the S-shaped paper clip to the loop at the end of the string.

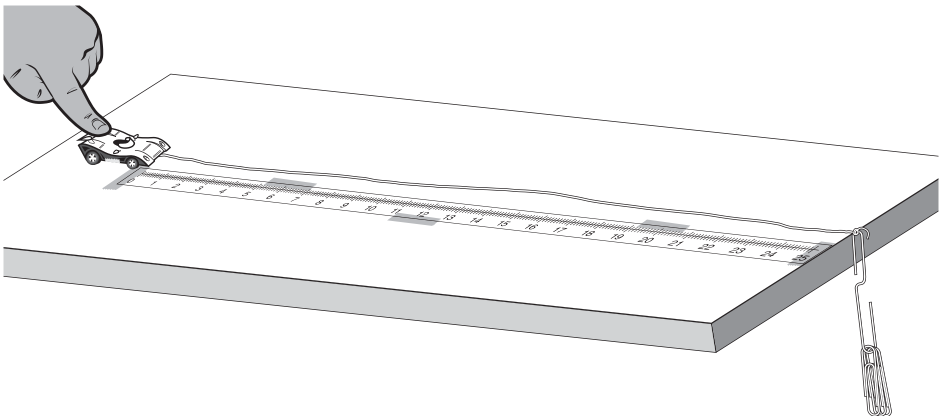


Figure 3.1: Completed car-and-string setup on elevated workstation

7. Make sure one member of each group holds the car in place on top of the work surface while the string and paper clip hang over the edge. The top of the S-shaped paper clip should be even with the top of the work surface.

8. Model how to set up the measuring tape by aligning the 0-cm mark of the measuring tape with the front of the car, taping it down with one of the smaller pieces of masking tape, and then extending the measuring tape to the front of the table. Students should secure this end of the measuring tape using a second small piece of masking tape. The remaining six pieces of masking tape should be placed in intervals along the measuring tape to hold it securely in place.

9. Using Part C of Student Investigation Sheet 3A, lead students in a test run of the car before they begin the investigation on their own. While one student holds the car in place, direct a second student to hang all six paper clips on the paper-clip hook at the end of the string. Explain that the student with the stopwatch should start timing at the same moment the other student releases the car and should stop timing the moment the car comes to a stop. Recommend that students quietly count down as a group.

Teaching Tip

Circulate around the classroom and make sure each group has set up the investigation correctly and has chosen students to time, hold the car, and load the paper clips.

10. Explain that to determine the distance the car traveled, students should read the number on the measuring tape that is aligned with the front of the car. This is the distance, in centimeters, that the car traveled.

11. Allow groups to practice setting up and releasing the car, using the stopwatch, and reading the tape measure a couple of times before beginning the investigation and recording data in the chart on the investigation sheet.

12. Once it seems each group understands the investigation procedure, allow them to begin conducting trials and filling in the Speed Chart in Part C of Student Investigation Sheet 3A. Remind students that they will repeat the investigation six times, once for each paper clip that is added.

Digital simulations to enrich concepts

13. Allow time for groups to complete all six trials and fill in the chart completely. Advise students to use their data to complete Part D of the investigation sheet.

Digital Tip

As you review, use the Force, Motion, Speed simulation to support students' observations of patterns.

14. Facilitate a class discussion about the results of the investigation. Ask:

- How was force increased in this system? *(More paper clips were added to the system.)*
- How did the force of gravity affect this system? *(The force of gravity pulled on the paper clips and applied a force to the car.)*
- Did you change the inertia of the car? *(Students should realize that they did not change the inertia of the car, but rather the force applied to the car. The larger the force they applied, the easier it was for the car to overcome its inertia.)*
- What conclusion can you draw about the motion of the car as the force increases? *(The car traveled farther in less time as force [number of paper clips] increased.)*

ELA connection SL.3.1

Formative assessment

15. Guide groups in cleanup. The tape measure will be reused in Investigation B, so instruct groups to leave them taped to the workstations. Ask groups to return their materials, including all the paper clips, to the resealable plastic bags. They should wrap the string around the car before placing it in the bag. Collect each group's bag.

Tell Me More!

The force of gravity pulls objects closer to Earth. Is there a way we can increase the speed at which an object falls?

Disciplinary Core Ideas
- **PS2.A:** Forces and Motion
- **PS2.B:** Types of Interactions

Science and Engineering Practices
- Developing and Using Models
- Constructing Explanations and Designing Solutions

Crosscutting Concept
- Patterns

5Es
- Explore
- Explain
- Elaborate

Literacy Component
- **Literacy Article 3B:** Clowning Around

Differentiation Strategy

Below-level students may continue to struggle to understand force's effect on motion. Push a marker and a book across the floor to provide a quick demonstration to show clearly how larger, heavier objects have more inertia and will require a stronger force to move.

Differentiation

Investigation B

HOW DOES MASS AFFECT THE MOTION OF AN OBJECT?

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 3B: *Can Mass Change Motion?*

Team of four students

6 Large paper clips*
1 Large washer
1 Piece of masking tape, 5 cm*
1 Piece of string, 1.5 m
2 Ring magnets
1 S-shaped paper clip*
6 Small washers
1 Stopwatch
1 Tape measure, 150 cm

Class

8 Elevated workstations at least 1.5 m in length*

Teacher

1 Student Investigation Sheet 3B: *Can Mass Change Motion?* (Teacher's Version)
8 Large resealable plastic bags

*These materials are needed but not supplied.

1. Review the concepts from the previous investigation. Ask:

- Describe the relationship between force and the motion of the car. *(The stronger force made the car move faster and farther.)*
- Explain why force is important in regard to inertia. *(The stronger the force applied, the easier it is for an object to overcome inertia.)*
- Think of a train and a tricycle. Which will require more force to overcome inertia? Why? *(Students should understand that the train will require more force to overcome inertia because it is heavier and harder to move than the tricycle.)*
- Do you think an object's mass affects its motion? *(Answers will vary.)*

2. Explain that students will investigate the effect of mass on motion. Distribute a bag of materials to each group of four students and one copy of Student Investigation Sheet 3B: *Can Mass Change Motion?* to each student. Explain that students will investigate the effect of mass on motion. Review the instructions in Part A for setting up the investigation.

3. Guide students to make a prediction in Part B. Ask a few students to share their predictions about the motion of the car as its mass increases.

4. Preview the directions in Part C of Student Investigation Sheet 3B. Guide groups to unwind the string from around the car, and then tape the large washer to the top of the car using the 5-cm strip of masking tape from their bag of materials. Point out that the tape should not touch the wheels. Students may need to reattach their measuring tapes if they were removed after Investigation A.

5. Allow time for groups to perform the investigation. Instruct students to complete the first column of the Distance Chart, labeled "Distance the Car + Large Washer Traveled." As students work, circulate throughout the room and make sure that groups are aligning the car properly at the start of each trial, attaching the proper number of washers to the hook each time, and recording their measurements in the first column of the Distance Chart on their investigation sheet.

6. When groups have completed the first column of the chart, they should add to the car's load by taping a ring magnet on top of the large washer on top of the car and retest the car with this heavier load, starting with one washer on the paper-clip hook. Students will repeat the procedure for two, three, four, five, and six washers on the paper-clip hook and record their data in the second column of the chart on the investigation sheet.

Teaching Tip

Make sure students continue to record their data in the appropriate column of the chart during each trial.

7. When groups have completed the second column of the chart, they should tape a second ring magnet to the top of the car and repeat the investigation a third time. Students will begin with one washer on the paper-clip hook and add one additional washer each time. Data for this trial should be recorded in the third column of the chart.

8. When groups have completed the chart, instruct them to review the results with their group members and work together to complete Part D of the investigation sheet.

Literacy Tip

To support the concepts related to mass and force affecting the speed of an object, ask students to read Literacy Article 3B: Clowning Around.

9. Facilitate a class discussion to review the results of the investigation and explain the relationship between the motion of the car and the mass of the car. Ask:

- How was mass increased in this system? *(Washers and magnets were added to the car.)*
- How was force increased in this system? *(Washers were added to the paper-clip hook.)*
- How did the force of gravity affect this system? *(The force of gravity pulled on the washers on the paper-clip hook and applied a force to the car.)*
- How did you affect the inertia of the car? *(Adding mass to the car and changing the force applied to it [adding washers to the paper-clip hook] affected the inertia of the car.)*
- What conclusions can you draw about the relationship between the mass, forces, and the motion of an object? *(Students should conclude that more force needs to be applied to make the car move as the car's load becomes heavier.)*
- What conclusion can you draw about the motion of the car as the force increases? *(The car traveled farther in less time as force [number of washers on the paper-clip hook] increased.)*
- How does mass affect friction? *(Friction stops the car more quickly as more mass is added because greater mass experiences a stronger pull from gravity.)*
- Relate this idea to the number of people on a merry-go-round. How are motion and force affected when there are more people on the ride? *(The more people on the ride, the more force is needed to make the ride spin.)*

ELA connection W.3.2

10. Have students remove the washer and the magnets from the car, and rewind the string around it. Students should return all the materials (including the tape measures) to the plastic bags. Collect the bags.

Tell Me More!

Explain why a larger washer has more inertia. How will this affect the magnetic force?

Investigation C

HOW CAN I INCREASE MAGNETIC FORCE?

MATERIALS

- **Student**

1 Science notebook*
1 Student Investigation Sheet 3C: *Can I Increase Magnetic Force?*

- **Team of four students**

2 Ring magnets
1 Small washer

*These materials are needed but not supplied.

1. Ask students to think about what they know about magnets and magnetic forces. Prompt them to create a two-column chart in their science notebooks. They should record what they know about magnets in one column and questions they have about magnets in the other column. After giving students some time to write down their ideas, explain that they will examine these forces in the following lessons. Encourage students to share what they know by asking the following questions:

- What are magnets made of? *(Metal)*
- What is unique about the way magnets behave? *(Magnets stick to some types of metal or to other magnets.)*
- How can we use magnets? *(Answers will vary. Students might mention separating metal objects.)*

2. Explain that students will determine the magnetic force of a magnet by measuring the distance from which a washer is attracted to the magnet. Distribute two ring magnets and one small washer to each group of four students. Allow time for students to test the materials to understand that the washer is attracted to the magnet and that the magnets are attracted to each other.

3. Provide each student with one copy of Student Investigation Sheet 3C: *Can I Increase Magnetic Force?* Guide students to complete Part A by making a prediction.

4. Review the directions for Part B of Student Investigation Sheet 3C, and then allow groups time to complete the investigation. When they have finished, direct students to review their results with their group members and draw conclusions based on their evidence to answer the question in Part C of the investigation sheet.

Disciplinary Core Ideas
- **PS2.A:** Forces and Motion
- **PS2.B:** Types of Interactions

Science and Engineering Practices
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions

Crosscutting Concepts
- Patterns
- Cause and Effect

5Es
- Explore
- Explain

Literacy Component
- *Forces and Interactions* Literacy Reader, pgs. 10–11

5. Facilitate a class discussion about groups' observations and conclusions. Ask:

- How did you increase the magnetic force in this investigation? *(Magnetic force was increased by adding a second magnet.)*
- How did the number of magnets affect the distance at which the the washer began to move? *(When there were two magnets, there was less distance between the washer and the magnets when the washer moved.)*
- What can you conclude about magnetic force? *(The magnetic force can be increased by adding more magnets.)*

ELA connection
SL.3.1, W.3.2

6. Direct students to update their two-column charts about magnetic forces based on what they have learned in this investigation. Provide time for students to ask questions. Explain that students will continue to investigate magnetism in the next lesson.

7. Collect the magnets and washers from each group.

Tell Me More!

Imagine you had a bigger magnet. Do you think a bigger magnet would increase or decrease the strength of the magnetic force? Explain your answer.

Phenomenon

Review students' questions about the investigative phenomenon from the beginning of this lesson. Guide students in applying the concepts explored in this lesson and connecting them to the anchoring phenomenon: identifying the interactions of forces at an amusement park. By the end of the lesson, students should be able to explain that:

- Changing direction requires extra force, but additional force may also cause an object to slow down.
- Adding an extra push will increase the force applied to an object.
- Objects must overcome inertia to move. Applying another force will affect an object's ability to remain in motion.
- Roller coasters have height and weight requirements because too much mass will affect the speed of the roller coaster and possibly make it move too fast or too slow.

Connecting ideas about phenomena to evidence

Math connection
3.OA.A.4, 3.OA.C.7

EXTENSIONS

How Many Grams?

Present students with the following story problem:

When experimenting with forces at the science center, Kevin, Cameron, and Tana planned a physics experiment using toy cars. They gathered three toy cars that were identical in size and mass. Tana found three washers in an envelope. One washer had “1 gram” etched into it. Tana placed that washer on a green car. A second washer had “6 grams” etched into it. Cameron placed that washer on a red car. The third washer had no etching. Kevin placed this washer on a purple car. Kevin, Tana, and Cameron raced their cars on a track. The purple car moved three times faster than the green car. The red car moved twice as fast as the purple car. What was the mass of the washer on the purple car?

Help students find the mass of the car using the following equations:

The purple car moved 3 times as fast as the green car, which had a 1-gram washer.

1 g x 3 g = 3 grams

The purple car moved at half the speed of the red car, which had a 6-gram washer.

6g ÷ 2g = 3 grams

Art in Motion

Italian painter Giacomo Balla (1871–1958) was one of the founding members of the Futurist Painters. This group of artists was interested in using light and shapes to show speed and movement in their artwork. Look for a few of Giacomo Balla’s paintings online and, as a class, explore each painting that you select. Discuss how it depicts movement. You might want to point out that in each, repetitive and overlapping shapes and lines as well as the use of light paint next to dark gives an illusion of movement.

After viewing the artwork, provide students with large paper and paint and have them create their own motion paintings.

Forces Make Things Move

Read *Forces Make Things Move (Let’s-Read-and-Find-Out Science 2)* by Kimberly Brubaker Bradley aloud to the class. Consider having several copies available so groups of students can read the book together as they complete the vocabulary activity below.

Reinforce important vocabulary such as “forces,” “reactions,” “inertia,” “friction,” and “gravity” by having students create illustrated flash cards. Have students write one word and its definition on the back of each of five index cards. They may use the book as reference for definitions if needed. On the front of each card, have students draw an image or diagram illustrating the word defined on the back.

Have students quiz each other using the completed flash cards.

Make a Splash

Place a large piece of bulletin board paper on the ground in a parking lot or playground. Pour blobs of different-colored tempera paint onto the paper. Have each student drop a ball from a different height into the paint. (Make sure students wear paint shirts or plastic ponchos so they do not get paint on their clothing.)

Discuss the differences in the size or shape created when the paint splashed from the force of the ball. Students should notice that the higher the height from which they release the ball, the faster the ball is moving when it hits the paint. This greater speed of the ball results in a more forceful impact and a bigger splash. Ask a volunteer to record the height from which each ball is dropped and a description of the paint splash that results.

Clean up and wash the balls when you are finished. Dry the splash painting overnight and then display it in the classroom. Invite students to label the splash painting based on their notes.

ASSESSMENT STRATEGIES

1. Investigation A

- Use Student Investigation Sheet 3A: *Can the Strength of a Force Change Motion?* to determine if students understand the effect of force on motion. Students should understand the concept that increasing force results in faster motion.

- Use students' responses to the Tell Me More question to gauge if they can identify forces acting upon a falling object. Gravity pulls at a constant rate, but the heavier an object is, the stronger the pull. Above-level students should acknowledge this concept.

2. Investigation B

- Use Student Investigation Sheet 3B: *Can Mass Change Motion?* to gauge students' understanding of the effect of mass on the motion of an object. Students should understand that increasing mass increases inertia, which affects the speed at which an object can move.

- Use students' responses to the Tell Me More question to determine how well they can combine concepts from this lesson. A larger washer is heavier and has more inertia than a small washer, so it will take more magnets to move the large washer than the small one.

3. Investigation C

- Use Student Investigation Sheet 3C: *Can I Increase Magnetic Force?* to assess how well students understand magnetic forces and the concept that an increased number of magnets will result in a stronger magnetic force.

- Use students' responses to the Tell Me More question to determine if they equate a larger magnet with a stronger magnetic force. Students should recognize that a larger magnet is similar to combining multiple magnets.

4. Use the General Rubric in Appendix A to assess individual progress as needed.

NOTES

Formative assessment—How are they progressing?

Student Investigation Sheet 3A

Name ______________________

Can the Strength of a Force Change Motion?

Date ______________________

Equipment:
1 Car
6 Large paper clips
2 Pieces of masking tape, 2.5 cm (1 in)
1 Piece of masking tape, 5 cm (2 in)
1 Piece of string, 1. 5 m (5 ft)
1 S-shaped paper clip
1 Stopwatch
1 Tape measure, 150 cm (60 in)

ELA and math connections
L.3.6, RI.3.3, SL.3.1, W.3.2, 3.NBT.A.1

A. Predict

How do you think the motion of a car will change as more force is applied? ______________________

B. Set Up

1. Tape the straight end of the string to the bottom of the car using a 5-cm (2-in) piece of masking tape. The string should extend out in front of the car. Wrap the tape around the body of the car, not the car's length, to secure the string. Place the car on top of a long, flat table.

2. Hook the S-shaped paper clip onto the loop end of the string. Allow the paper clip to hang off the edge of the table.

3. Select one group member to pull the car back until the top of the paper clip is aligned with the edge of the table. Hold the car in place.

4. Set up the measuring tape by aligning the 0-cm mark of the measuring tape with the front of the car, and secure it with a piece of masking tape. Extend the measuring tape to the front of the table. Secure this end of the measuring tape with a second piece of masking tape. Use the remaining six pieces of masking tape in intervals along the length of the measuring tape to hold it securely in place.

5. Select another group member to set the stopwatch to zero.

C. Observe and Record

1. Release the car and start the stopwatch at the exact same time. You may want to count down as a group.

2. When the car stops rolling, stop the stopwatch. Record the time in seconds on the Speed Chart below.

3. Measure the distance the car traveled, and record this in centimeters on the Speed Chart.

NOTE: If the car does not move within 2 seconds, record the distance as zero.

4. In the last column, record any observations of the car's movement.

5. Reset the car by pulling it back until the top of the paper clip is aligned with the edge of the table. Hang one paper clip on the paper clip hook at the end of the string.

6. Release the car and start the stopwatch at the exact same time.

7. When the car stops rolling, stop the stopwatch. Measure the distance the car traveled in centimeters, and record that distance and the time in seconds on the Speed Chart in the row for one paper clip. In the last column, record your observations of the car's movement.

8. Repeat Steps 5–7, and add one paper clip each time. Be sure to record the distance traveled and the time it took in the Speed Chart for each trial, as well as your observations of the car's movement.

Speed Chart

Number of Paper Clips (Force)	Distance the Car Traveled (Centimeters)	Amount of Time (Seconds)	Observations of the Car's Movement
0			
1			
2			
3			
4			
5			
6			

D. Conclude

1. How does force affect motion? ______

2. What evidence from the investigation suggests that force affects motion? ______

3. How did adding paper clips affect the distance and the amount of time the car traveled?

Name ______________________________

Date ______________________________

Clowning Around

Many people love to laugh at clowns. Clowns dress in silly ways and act goofy. They try to make people laugh. Sometimes clowns act alone. Other times, they work together. You may have seen many clowns at a circus or a parade spill out of a clown car.

The act begins with a small car driving very slowly into view. The car stops, and one clown gets out. As the seconds tick by, clown after clown exits the car. The audience is amazed that all those clowns could fit in one tiny car!

After the final clown exits the car, the driver steps back into the vehicle. Waving goodbye to the crowd, he speeds away. The other clowns chase after the car.

Mass is how much matter is in an object. Mass has a direct result on how fast something can move. The clown car approaches slowly because all the clowns inside have a lot of mass. It speeds away because only one clown is inside. Think about a time you walked down the hallway with your class. Was it an easy walk? Were you out of breath? Now imagine walking to class with your backpack full of heavy books. Was it still an easy walk? Could you walk as fast as you did without the backpack on? How did the mass of the backpack affect your walk?

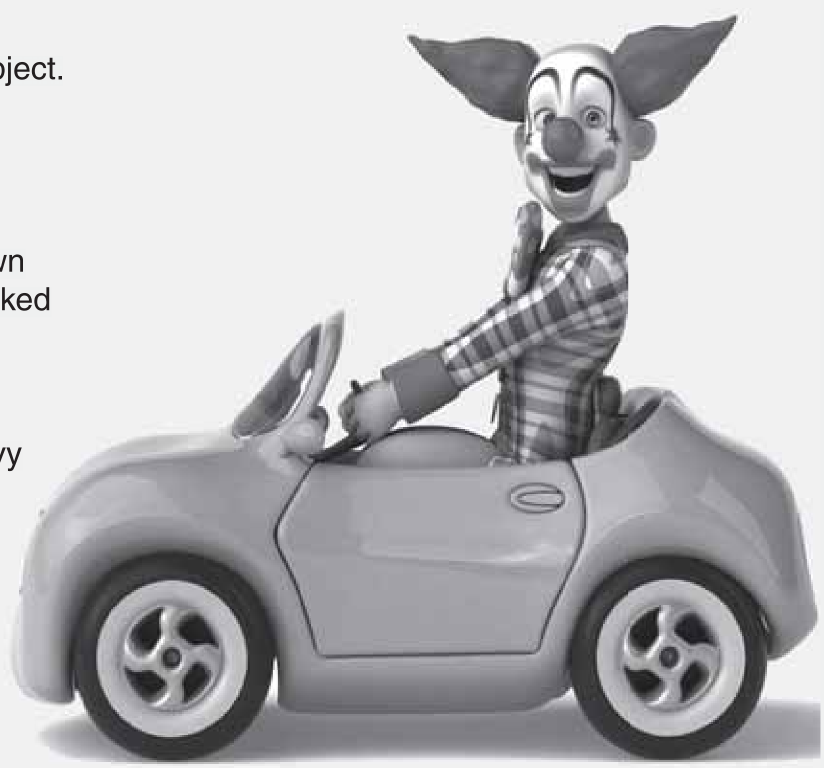
The next time you pack up your backpack, think about how the mass of the items in it will affect how you move.

Questions:

1. How does the mass of the full clown car affect the amount of friction acting on the car?

2. Which would be harder to move: an empty shopping cart or a full one?

3. Imagine a clown car has eight clowns inside. Two clowns get out and sit on top of the car. Will the car move faster or slower? Explain your reasoning.



Credit: By Julien Tromeur/Shutterstock.com

Student Investigation Sheet 3B

Name ______________________

Can Mass Change Motion?

Date ______________________

Equipment:

- 1 Car with string attached
- 1 Large washer
- 1 Piece of masking tape 5 cm (2 in)
- 2 Ring magnets
- 1 S-shaped paper clip
- 6 Small washers
- 1 Tape measure, 150 cm (60 in)

A. Set Up

1. Attach a large washer to the top of the car with a piece of masking tape.

2. Place the car on top of a long, flat table with the string extending out in front of it.

3. Hook the S-shaped paper clip onto the loop on the free end of the string.

4. Allow the paper clip to hang off the edge of the table.

5. Select one group member to pull the car back until the top of the paper clip is aligned with the edge of the table, and hold the car in place.

B. Predict

How will the motion of the car change when the mass of the car changes?

____

____

____

____

ELA connection
L.3.6, RI.3.3, SL.3.1, W.3.2

C. Observe and Record

1. With no washers on the paper-clip hook at the end of the string, release the car. Record the distance the car travels in centimeters in the chart below. If the car does not move after 2 seconds, record the distance traveled as 0 cm.

2. Reset the car by pulling it back until the top of the paper clip is aligned with the edge of the table. Place one small washer on the paper-clip hook, and release the car. When the car stops moving, record the distance traveled in centimeters on the chart below.

3. Reset the car by pulling it back until the top of the paper clip is aligned with the edge of the table. Add a second small washer to the paper clip hook.

4. Release the car. When the car stops moving, record the distance traveled in centimeters on the chart.

5. Repeat Steps 3 and 4, adding one small washer each time and recording the distance traveled in centimeters for each trial chart until you have tested six washers and completed the first column of the chart.

6. Add one ring magnet on top of the car, and secure it with tape. Repeat Steps 2–5, recording your data in the second column of the chart.

7. Add a second ring magnet on top of the car, and secure it with tape. Repeat Steps 2–5, recording your data in the third column of the chart.

Distance Chart

Number of Small Washers (Force)	Distance the Car + Large Washer Traveled (Centimeters)	Distance the Car + Large Washer + Magnet Traveled (Centimeters)	Distance the Car + Large Washer + Two Magnets Traveled (Centimeters)
0			
1			
2			
3			
4			
5			

D. Conclude

1. How does mass affect motion? ______

2. What evidence from the investigation suggests that mass affects motion? ______

3. Describe the connection between force, mass, and the speed of the car. ______

Student Investigation Sheet 3C

Can I Increase Magnetic Force?

Name ____________________

Date ____________________

Equipment: 2 Ring magnets 1 Small washer

ELA and math connections L.3.6, RI.3.3, SL.3.1, W.3.2, 3.MD.B.3

A. Predict

How will changing the number of magnets affect the magnetic force?

____

____

____

____

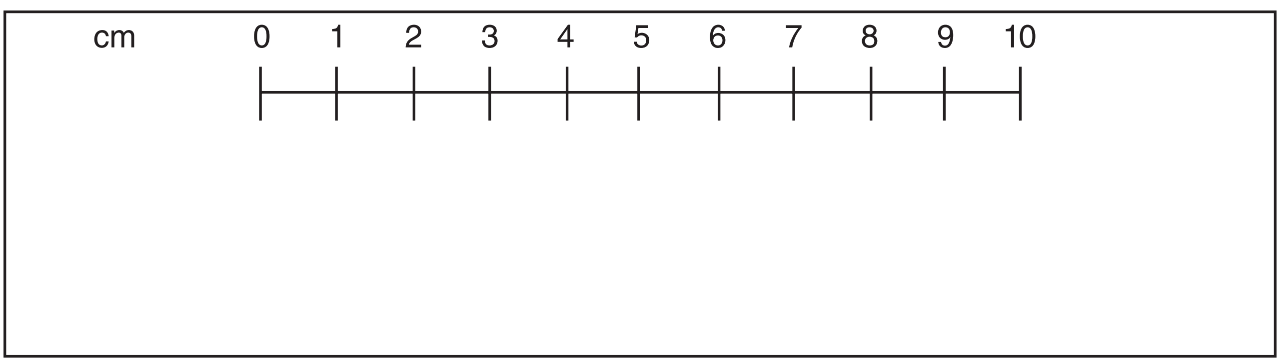
B. Observe and Record

1. On the ruler below, place one washer at 10 centimeters (cm) and stand one ring magnet on its side at 0 cm.

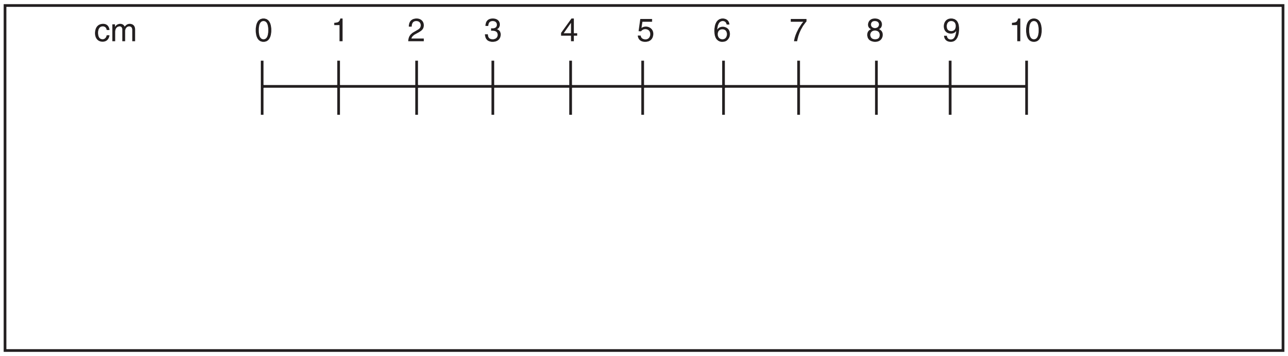
2. Trace or draw the washer and ring magnet on the ruler.

3. Move the washer one centimeter at a time toward the ring magnet.

4. How far away was the washer when it moved toward the ring magnet? ___ cm



5. On the ruler below, place one washer at 10 cm. Connect two ring magnets and place them at 0 cm.



6. Move the washer one centimeter at a time toward the ring magnets.

7. How far away was the washer when it moved toward the magnets? ___ cm

C. Conclude

1. How can the strength of magnetic force be changed?

2. What evidence from your investigation suggests that magnetic force can be changed?

3. Compare magnetic force to other types of force. What patterns do you notice?

Student Investigation Sheet 3A: Teacher's Version

Can the Strength of a Force Change Motion?

A. Predict

How do you think the motion of a car will change as more force is applied? *(Students' predictions will vary.)*

B. Set Up

1. Tape the straight end of the string to the bottom of the car using a 5-cm (2-in) piece of masking tape. The string should extend out in front of the car. Wrap the tape around the body of the car, not the car's length, to secure the string. Place the car on top of a long, flat table.

2. Hook the S-shaped paper clip onto the loop end of the string. Allow the paper clip to hang off the edge of the table.

3. Select one group member to pull the car back until the top of the paper clip is aligned with the edge of the table. Hold the car in place.

4. Set up the measuring tape by aligning the 0-cm mark of the measuring tape with the front of the car, and secure it with a piece of masking tape. Extend the measuring tape to the front of the table. Secure this end of the measuring tape with a second piece of masking tape. Use the remaining six pieces of masking tape in intervals along the length of the measuring tape to hold it securely in place.

5. Select another group member to set the stopwatch to zero.

C. Observe and Record

(Groups' measurements of distance and time will vary. Look for accurately recorded information and reasonable observations of the car's movement each time.

D. Conclude

1. How does force affect motion? *(The amount of force applied to an object will cause the object to move faster or slower. The amount of force applied to an object also affects how far it will move.)*

2. What evidence from the investigation suggests that force affects motion? *(When more paper clips were added [when more force was applied], the car moved faster down the length of the table. When there were fewer paper clips, the car moved more slowly and sometimes did not move the length of the table.)*

3. How did adding paper clips affect the distance and amount of time the car traveled? *(Adding more paper clips made the car move across the table faster.)*

Clowning Around

Many people love to laugh at clowns. Clowns dress in silly ways and act goofy. They try to make people laugh. Sometimes clowns act alone. Other times, they work together. You may have seen many clowns at a circus or a parade spill out of a clown car.

The act begins with a small car driving very slowly into view. The car stops, and one clown gets out. As the seconds tick by, clown after clown exits the car. The audience is amazed that all those clowns could fit in one tiny car!

After the final clown exits the car, the driver steps back into the vehicle. Waving goodbye to the crowd, he speeds away. The other clowns chase after the car.

Mass is how much matter is in an object. Mass has a direct result on how fast something can move. The clown car approaches slowly because all the clowns inside have a lot of mass. It speeds away because only one clown is inside. Think about a time you walked down the hallway with your class. Was it an easy walk? Were you out of breath? Now imagine walking to class with your backpack full of heavy books. Was it still an easy walk? Could you walk as fast as you did without the backpack on? How did the mass of the backpack affect your walk?

The next time you pack up your backpack, think about how the mass of the items in it will affect how you move.

Questions:

1. How does the mass of the full clown car affect the amount of friction acting on the car? *(The mass of the full car pushes down and causes more friction.)*

2. Which would be harder to move: an empty shopping cart or a full one? *(A full cart would be harder to move.)*

3. Imagine a clown car has eight clowns inside. Two clowns get out and sit on top of the car. Will the car move faster or slower? Explain your reasoning. *(The car will move at the same speed because the mass did not change.)*

Credit: By Julien Tromeur/Shutterstock.com

Student Investigation Sheet 3B: Teacher's Version

Can Mass Change Motion?

A. Set Up

1. Attach a large washer to the top of the car with a piece of masking tape.

2. Place the car on top of a long, flat table with the string extending out in front of it.

3. Hook the S-shaped paper clip onto the loop on the free end of the string.

4. Allow the paper clip to hang off the edge of the table.

5. Select one group member to pull the car back until the top of the paper clip is aligned with the edge of the table, and hold the car in place.

B. Predict

How will the motion of the car change when the mass of the car changes? *(Students' predictions will vary.)*

C. Observe and Record

1. With no washers on the paper-clip hook at the end of the string, release the car. Record the distance the car travels in centimeters in the chart below. If the car does not move after 2 seconds, record the distance traveled as 0 cm.

2. Reset the car by pulling it back until the top of the paper clip is aligned with the edge of the table. Place one small washer on the paper-clip hook and release the car. When the car stops moving, record the distance traveled in centimeters on the chart below.

3. Reset the car by pulling it back until the top of the paper clip is aligned with the edge of the table. Add a second small washer to the paper clip hook.

4. Release the car. When the car stops moving, record the distance traveled in centimeters on the chart.

5. Repeat Steps 3 and 4, adding one small washer each time and recording the distance traveled in centimeters for each trial chart until you have tested six washers and completed the first column of the chart.

6. Add one ring magnet on top of the car, and secure it with tape. Repeat Steps 2–5, recording your data in the second column of the chart.

7. Add a second ring magnet on top of the car, and secure it with tape. Repeat Steps 2–5, recording your data in the third column of the chart.

Distance Chart

(Students' charts will vary based on how accurately they set up for each trial. Data should show that the car traveled shorter distances each time mass was added.)

D. Conclude

1. How does mass affect motion? *(Heavier objects do not move as fast or as far as lighter objects when the same amount of force is applied.)*

2. What evidence from the investigation suggests that mass affects motion? *(The car with the greater mass moved more slowly as force was added. The car with less mass moved faster.)*

3. Describe the connection between force, mass, and the distance the car travels. *(When the force increased, the car moved a greater distance. However, when the car's mass was increased but the same amount of force was applied, the car either moved a shorter distance than before or moved more slowly over the same distance as before.)*

Summative Assessment

Name ______________________

Date ______________________

What have they learned?

1. You drop a quarter. As the quarter falls, it is experiencing:

a. A push
b. A pull
c. Magnetism
d. A balanced force

2. You place a 5-gram weight on one side of a balance. Which object could be added to the other side to balance the beam?

a. Several paper clips
b. A gallon of water
c. An inflated balloon
d. The beam is already balanced.

3. An object is in motion. A push force acts upon the moving object. Choose the most likely effect:

a.The object's forces become balanced.
b. The object changes direction.
c. The object stops.
d. The object experiences electric forces.

4. Name two things that slow down a moving bowling ball.

a. ____________________ **b.** ____________________

5. Which object would be attracted to a magnet?

a. Plastic water bottle
b. A penny
c. Aluminum foil
d. Iron filings

NOTES

Building Blocks of Science Student Literacy

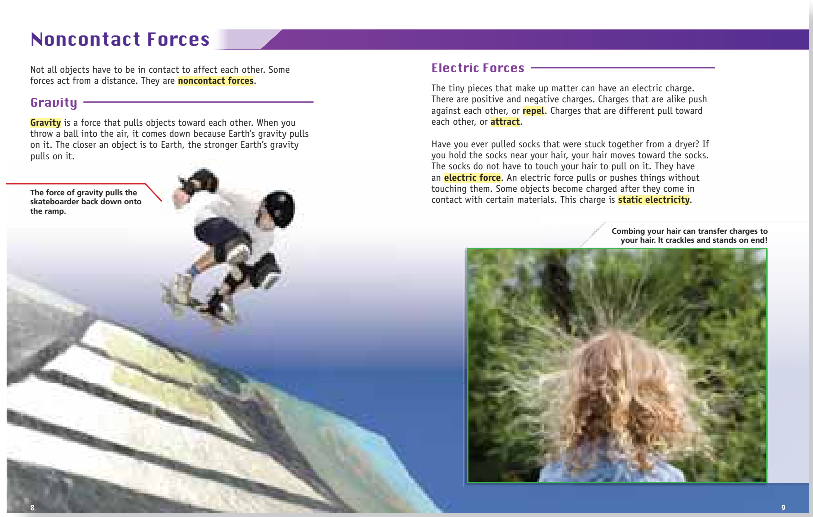
Build students' literacy skills with literacy components found within lessons and Literacy Readers.

Building Blocks of Science Literacy Components can be used to:

- Introduce a new lesson
- Support an investigation
- Incorporate science connections into your language arts sessions
- Differentiate instruction
- Review previously learned concepts

Literacy Readers—on-level and below-level readers in **English and Spanish** and available in **print or digital format**—provide informational text that:

- Incorporates English language arts and literacy standards
- Uses supporting text with graphs, vocabulary, charts, data, illustrations, and photographs to address **science concepts** related to lessons
- Provides opportunities to practice skills such as analysis and reasoning, and communication of ideas through **crosscutting concept** questions
- Challenges students to exercise and apply knowledge to a **science and engineering practice** activity
- Features a career that provides real-world insight into related science content



Noncontact Forces

Not all objects have to be in contact to affect each other. Some forces act from a distance. They are **noncontact forces**.

Gravity

Gravity is a force that pulls objects toward each other. When you throw a ball into the air, it comes down because Earth's gravity pulls on it. The closer an object is to Earth, the stronger Earth's gravity pulls on it.

The force of gravity pulls the skateboarder back down onto the ramp.

Electric Forces

The tiny pieces that make up matter can have an electric charge. There are positive and negative charges. Charges that are alike push against each other, or **repel**. Charges that are different pull toward each other, or **attract**.

Have you ever pulled socks that were stuck together from a dryer? If you hold the socks near your hair, your hair moves toward the socks. The socks do not have to touch your hair to pull on it. They have an **electric force**. An electric force pulls or pushes things without touching them. Some objects become charged after they come in contact with certain materials. This charge is **static electricity**.

Combing your hair can transfer charges to your hair. It crackles and stands on end!

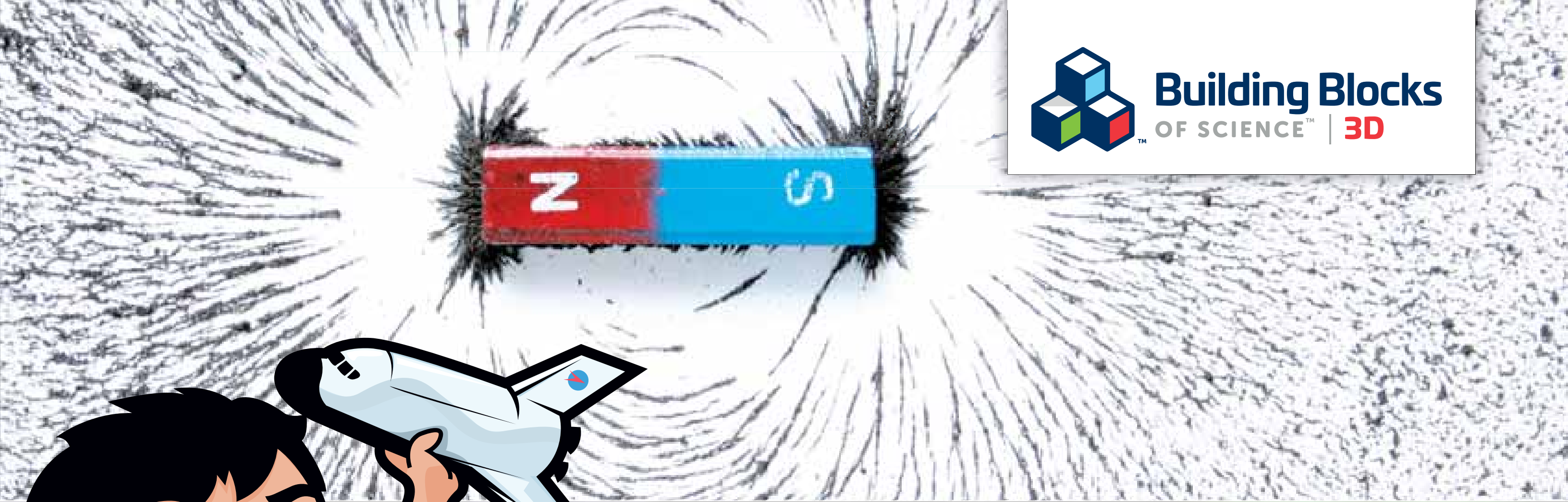
8 9

What else to look for?

Literacy Articles—These encourage students to elaborate upon unit topics, discuss real-world applications and phenomena, and ask student to connect this to concepts in the unit. Corresponding questions ask student to access high-level thinking and draw upon previous knowledge. (See page 37 of this sampler for an example.)

Science in the News Article Report—Students analyze a content-relevant reading or current event article, developing literacy skills as students identify important information, apply vocabulary, and draw connections to science content.

Building Blocks OF SCIENCE™ | 3D



Forces and Interactions

Student literacy–
available in
digital and print

Motion and Forces

Motion

Think of all the ways you can move on a playground. You can climb up or down a ladder. You can move around and around on a slide that curves. You can move back and forth on a swing. You can run in a zigzag motion when you play tag. **Motion** is a change in your position. **Position** is your location.

An object can keep moving in one direction or it can change direction. Objects can also move at different speeds. **Speed** is how fast something moves.

You can observe many kinds of motion on a playground.

Patterns of Motion

ELA connection RI.3.3

Blow a soap bubble through a wand. Your breath pushes it straight out from the wand. But then the wind will push the bubble in another direction. The motion of the bubble is irregular, or random.

Other motion *can* be predicted. **Regular motion** follows a pattern. A **pattern** is something that repeats over and over. Think about how a swing moves. It moves back and forth, over and over. A seesaw also has a regular motion. It goes up and down in the same way each time it moves.

The motion of a swing follows a predictable pattern.

Careers

Science in the world

Civil Engineer

People depend on bridges and roads to get where they need to go. Civil engineers decide what kinds of bridges or roads to build. They think about what machines will make work easier. They need to know how forces affect the movement of cars and trucks. They make drawings and use computers to help them.

Civil engineers study the forces that moving vehicles apply to a bridge.

Would I like this career?	You might like this career if • you like to work both inside and outdoors. • you like to plan how to build things. • you find bridges and moving cars interesting.
What would I do?	• You would plan how to build large structures. • You would do research about different places. • You would learn about cars and traffic.
How can I prepare for this career?	• Study science and math. • Develop good drawing and computer skills. • Observe how forces affect motion.

Profesiones

Ingeniero civil

La gente depende de caminos y puentes para ir adonde tienen que ir. Los ingenieros civiles deciden qué puentes y carreteras construir. Piensan en máquinas que facilitarían el trabajo. Piensan en las fuerzas que afectan el movimiento de autos y camiones. Ellos dibujan y usan computadoras para hacer su trabajo.

Los ingenieros civiles estudian las fuerzas que ejercen sobre este puente los autos en movimiento.

¿Me gustaría esta profesión?	Te gustaría esta profesión si • te gusta trabajar tanto en interiores como exteriores. • te gusta hacer planos para construir cosas. • te interesan los puentes y autos en movimiento.
¿Qué tendría que hacer?	• Planificarías cómo construir estructuras grandes. • Harías investigaciones acerca de distintos lugares. • Aprenderías sobre autos y el tránsito.
¿Cómo puedo prepararme para esta profesión?	• Estudia ciencias y matemáticas. • Desarrolla buenas destrezas computacionales y de dibujo. • Observa el efecto de las fuerzas sobre el movimiento.

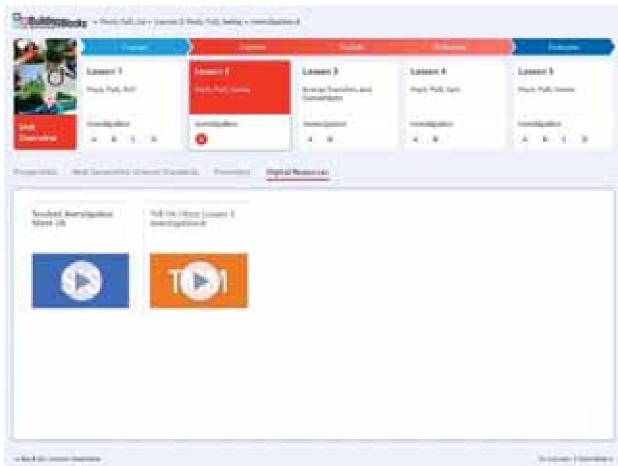
The Right Blend of Hands-On Investigation and Technology

Along with hands-on learning, Building Blocks of Science provides digital resources to enhance the classroom experience, offering an additional method of delivering content and support for teachers.

Support for Teachers

Everything you need to teach the lesson

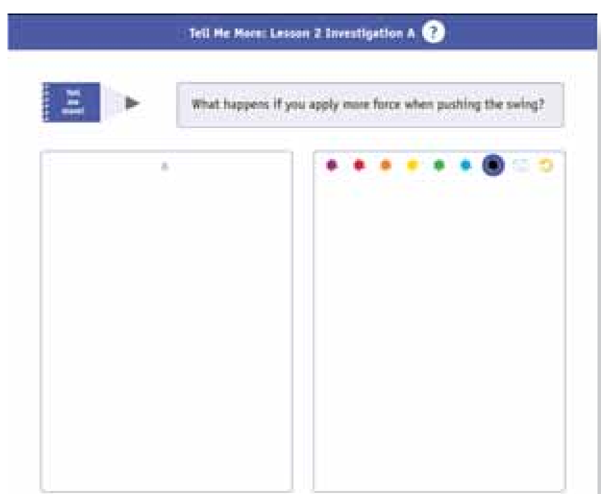
- Identification of where a lesson falls within the **5E Learning Cycle**
- **Preparation**—Includes investigation overview, materials list, and step-by-step teacher preparation instructions
- **NGSS Standards**—Includes the PEs, DCIs, SEPs, and CCCs that will be addressed within the investigation
- **Lesson Procedure**—step-by-step instruction for each investigation within a lesson
- **Digital Resources**—all the digital resources available in one place, by lesson and by individual investigations within each lesson



Digital resources by lesson

Everything you need to teach ALL your students

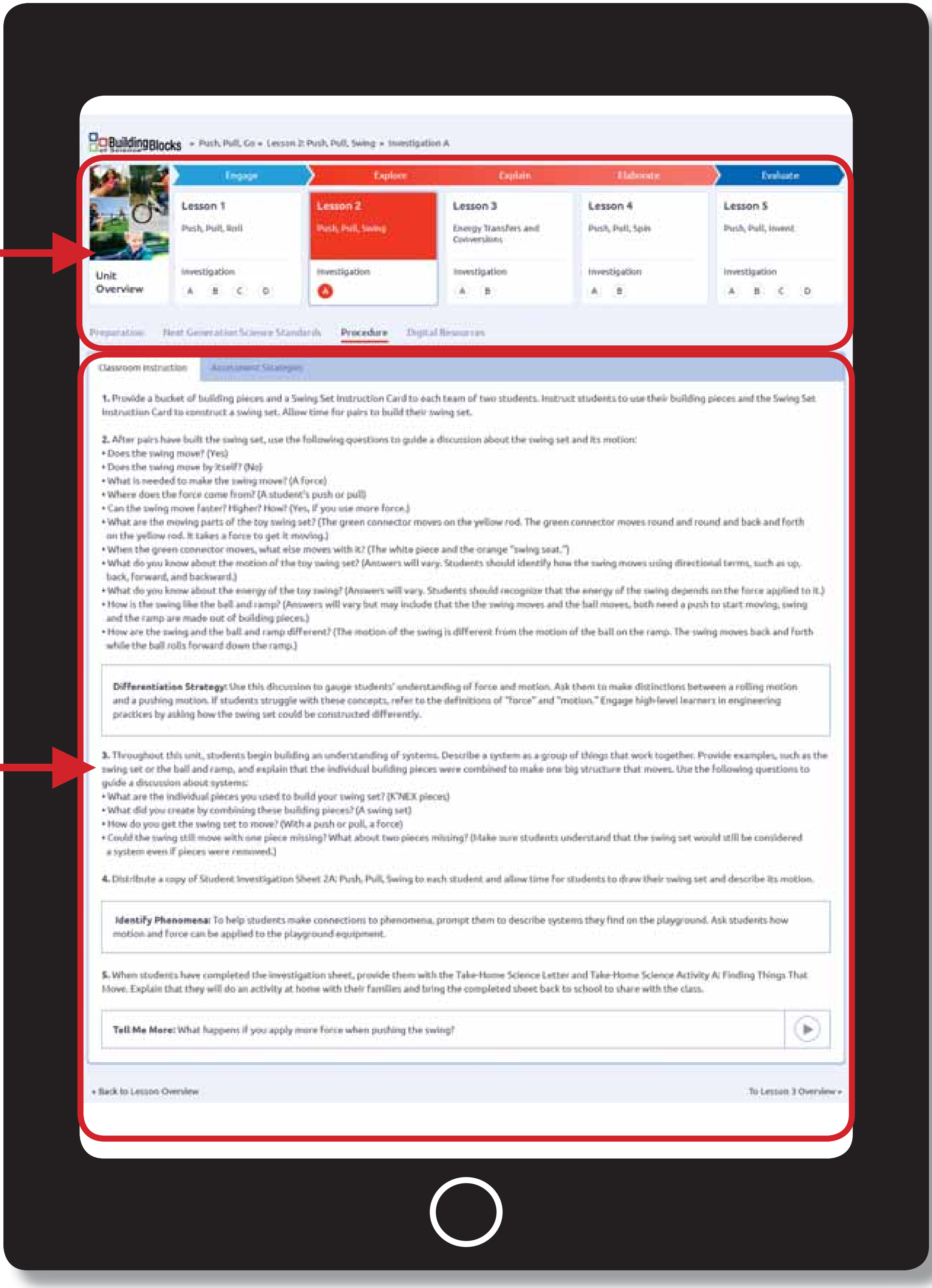
- Step-by-step instruction including guiding questions and anticipated responses
- Differentiation strategies at point of use within each investigation
- **Identify Phenomena** provides teachers with prompts to help students make connections to phenomena addressed within an investigation
- Assessment Strategies including **Tell Me More** formative assessment to help gauge student understanding



Tell Me More, a formative assessment strategy

For a closer look, visit:

www.carolina.com/bbs3dreview


BuildingBlocks » Push, Pull, Go » Lesson 2: Push, Pull, Swing » Investigation A

Unit Overview	Engage	Explore	Explain	Elaborate	Evaluate
	Lesson 1 Push, Pull, Roll Investigation A B C D	Lesson 2 Push, Pull, Swing Investigation A	Lesson 3 Energy Transfers and Conversions Investigation A B	Lesson 4 Push, Pull, Spin Investigation A B	Lesson 5 Push, Pull, Invent Investigation A B C D

Preparation | Next Generation Science Standards | Procedure | Digital Resources

Classroom Instruction | Assessment Strategies

1. Provide a bucket of building pieces and a Swing Set Instruction Card to each team of two students. Instruct students to use their building pieces and the Swing Set Instruction Card to construct a swing set. Allow time for pairs to build their swing set.

2. After pairs have built the swing set, use the following questions to guide a discussion about the swing set and its motion:
• Does the swing move? (Yes)
• Does the swing move by itself? (No)
• What is needed to make the swing move? (A force)
• Where does the force come from? (A student's push or pull)
• Can the swing move faster? Higher? How? (Yes, if you use more force.)
• What are the moving parts of the toy swing set? (The green connector moves on the yellow rod. The green connector moves round and round and back and forth on the yellow rod. It takes a force to get it moving.)
• When the green connector moves, what else moves with it? (The white piece and the orange "swing seat.")
• What do you know about the motion of the toy swing set? (Answers will vary. Students should identify how the swing moves using directional terms, such as up, back, forward, and backward.)
• What do you know about the energy of the toy swing? (Answers will vary. Students should recognize that the energy of the swing depends on the force applied to it.)
• How is the swing like the ball and ramp? (Answers will vary but may include that the the swing moves and the ball moves, both need a push to start moving, swing and the ramp are made out of building pieces.)
• How are the swing and the ball and ramp different? (The motion of the swing is different from the motion of the ball on the ramp. The swing moves back and forth while the ball rolls forward down the ramp.)

Differentiation Strategy: Use this discussion to gauge students' understanding of force and motion. Ask them to make distinctions between a rolling motion and a pushing motion. If students struggle with these concepts, refer to the definitions of "force" and "motion." Engage high-level learners in engineering practices by asking how the swing set could be constructed differently.

3. Throughout this unit, students begin building an understanding of systems. Describe a system as a group of things that work together. Provide examples, such as the swing set or the ball and ramp, and explain that the individual building pieces were combined to make one big structure that moves. Use the following questions to guide a discussion about systems:
• What are the individual pieces you used to build your swing set? (K'NEX pieces)
• What did you create by combining these building pieces? (A swing set)
• How do you get the swing set to move? (With a push or pull, a force)
• Could the swing still move with one piece missing? What about two pieces missing? (Make sure students understand that the swing set would still be considered a system even if pieces were removed.)

4. Distribute a copy of Student Investigation Sheet 2A: Push, Pull, Swing to each student and allow time for students to draw their swing set and describe its motion.

Identify Phenomena: To help students make connections to phenomena, prompt them to describe systems they find on the playground. Ask students how motion and force can be applied to the playground equipment.

5. When students have completed the investigation sheet, provide them with the Take-Home Science Letter and Take-Home Science Activity A: Finding Things That Move. Explain that they will do an activity at home with their families and bring the completed sheet back to school to share with the class.

Tell Me More: What happens if you apply more force when pushing the swing?

« Back to Lesson Overview | To Lesson 3 Overview »

Digital Components to Support Instruction and Assessment

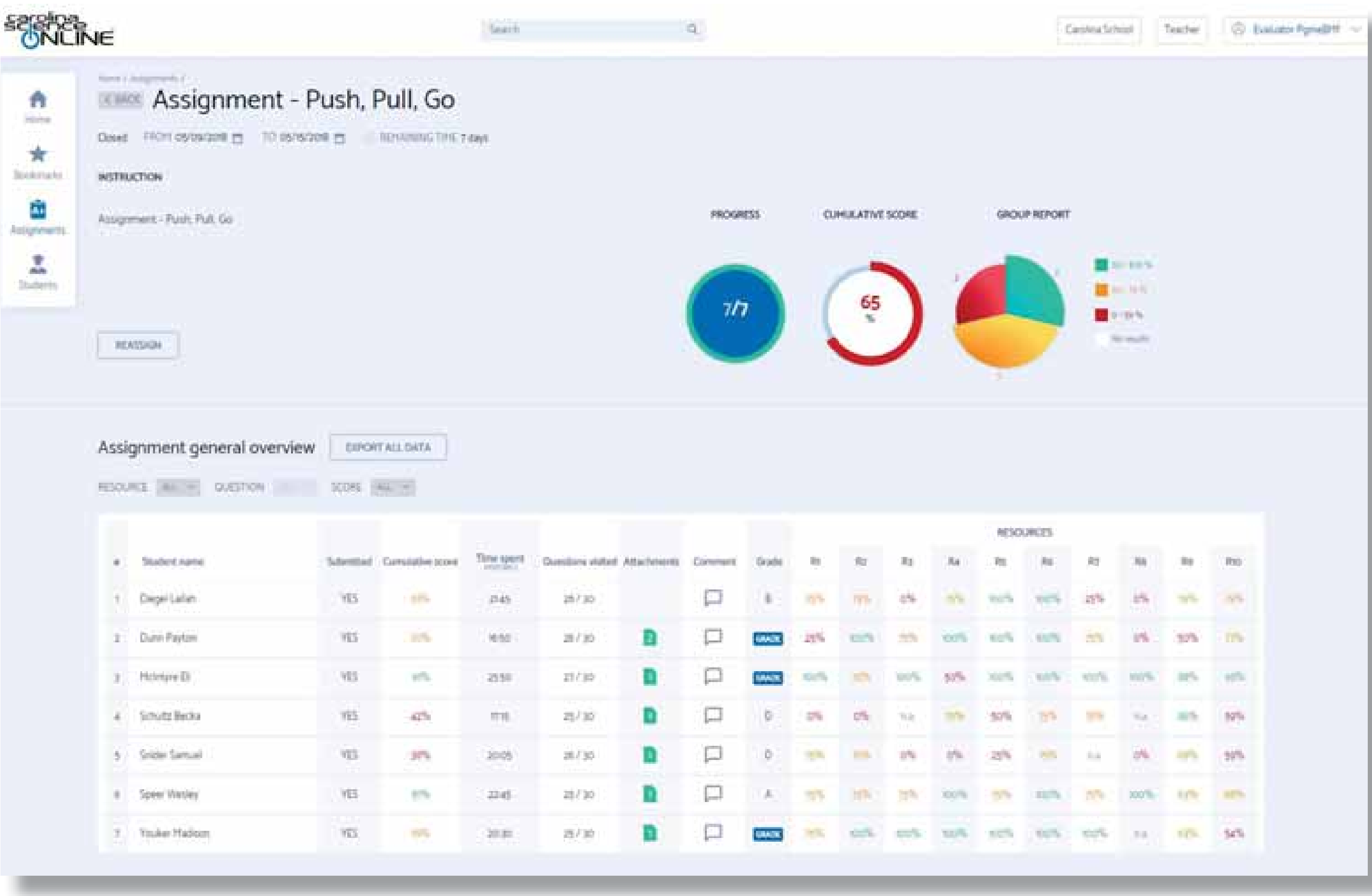
For the Teacher–Customizable Digital Planning at Your Fingertips

Building Blocks of Science 3D goes beyond just providing you access to your content. You can also:

- Use the assignment management system to create and grade custom assignments for classes and individual students to help differentiate instruction
- Create customizable bookmarks that include your student and instruction resources as well as URL links, PDF files, PowerPoint® presentations, and video files

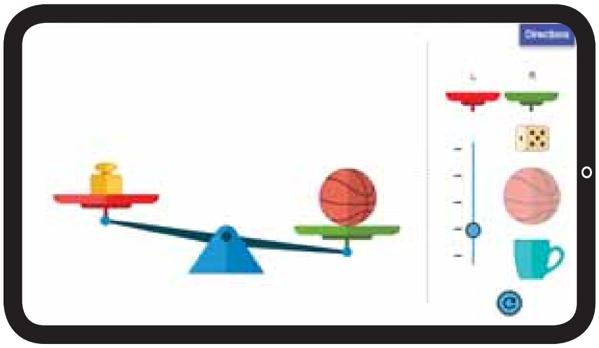
The assignment management system dashboard allows you to:

- Track the progress of your classes and individual students
- See student assignment results for the class at a glance and by individual student in detail
- Automatically grade close-ended questions (e.g., multiple choice, matching, fill-in-the-blank)
- Adjust student grades based on individual student performance and open-ended responses
- Assign remediation to student groups that need additional support or enrichment to groups that need a challenge



Digital components for students enhance and deepen student understanding, differentiate learning, and provide multiple modalities for delivering information.

"Digital Tips" take the guesswork out of integrating the following digital resources with hands-on investigations:



Simulations: Flexible enough to be used to introduce, support, or review a topic or concepts. Simulations are manipulative and provide a visual for differentiation.

Interactive Whiteboard Activities: With typing and drawing capabilities, IWB activities bring investigation-aligned classroom charts to life and are perfect for individual student review.

Student Investigation Sheets:
Students record their observations and data digitally when completing investigations.

Interactive Literacy Readers:
These enhanced versions of the printed student readers include check-for-understanding questions and animations to support the concepts covered in the text, enforce literacy skills, and provide additional practice.

Building Blocks OF SCIENCE™ | 3D

CAROLINA®
www.carolina.com

Learning Framework

Kindergarten	**Push, Pull, Go** *K-PS2-1; K-PS2-2; K-2-ETS1-1;K-2-ETS1-2*	**Living Things and Their Needs** *K-LS1-1; K-ESS2-2;K-ESS3-1;K-ESS3-3; K-2-ETS1-2*	**Weather and Sky** *K-PS3-1;K-PS3-2;K-ESS2-1; K-ESS3-2; K-2-ETS1-1; K-2-ETS1-2*
1st Grade	**Light and Sound Waves** *1-PS4-1; 1-PS4-2; 1-PS4-3; 1-PS4-4; K-2-ETS1-1; K-2-ETS1-2*	**Exploring Organisms** *1-LS1-1; 1-LS1-2; 1-LS3-1; K-2-ETS1-2*	**Sky Watchers** *1-ESS1-1; 1-ESS1-2*
2nd Grade	**Matter** *2-PS1-1; 2-PS1-2; 2-PS1-3; 2-PS1-4; K-2-ETS1-1; K-2-ETS1-2*	**Ecosystem Diversity** *2-LS2-1; 2-LS2-2; 2-LS4-1; K-2-ETS1-2; K-2-ETS1-3*	**Earth Materials** *2-PS1-1; 2-ESS1-1; 2-ESS2-1; 2-ESS2-2; 2-ESS2-3; K-2-ETS1-1; K-2-ETS1-2*
3rd Grade	**Forces and Interactions** *3-PS2-1; 3-PS2-2; 3-PS2-3; 3-PS2-4; 3-5-ETS1-1; 3-5 ETS1-2*	**Life in Ecosystems** *3-LS1-1; 3-LS2-1; 3-LS3-1; 3-LS3-2; 3-LS4-1; 3-LS4-2; 3-LS4-3; 3-LS4-4; 3-5-ETS1-2*	**Weather and Climate Patterns** *3-ESS2-1; 3-ESS2-2;3-ESS3-1; 3-5-ETS1-2*
4th Grade	**Energy Works** *4-PS3-1; 4-PS3-2; 4-PS3-3; 4-PS3-4; 4-PS4-1; 4-PS4-3; 4-ESS3-1; 3-5 ETS1-2; 3-5-ETS1-3*	**Plant and Animal Structures** *4-LS1-1; 4-LS1-2; 4-PS4-2; 3-5-ETS1-2*	**Changing Earth** *4-ESS1-1; 4-ESS2-1; 4-ESS2-2; 4-ESS3-2; 3-5-ETS1-2*
5th Grade	**Structure and Properties of Matter** *5-PS1-1; 5-PS1-2; 5-PS1-3; 5-PS1-4; 3-5-ETS1-2*	**Matter and Energy in Ecosystems** *5-PS3-1; 5-LS1-1; 5-LS2-1; 5-ESS2-1; 5-ESS3-1; 3-5-ETS1-3*	**Earth and Space Systems** *5-PS2-1; 5-ESS1-1; 5-ESS1-2; 5-ESS2-1; 5-ESS2-2; 5-ESS3-1; 3-5-ETS1-2*

Phenomenon-based investigations with digital support in 30-minute lessons!
For more information, visit www.carolina.com/bbs

CCPBB18110905