GRADE 4

Building Blocks OF SCIENCE™ | 3D

Energy Works

Program Highlights and Lesson Sampler

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

Table of Contents

Inside this sampler, you will find:

Energy Works

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	Lesson 6
Battery, D cell	35			■		■	■
Battery holder	35			■		■	■
Bulb holder	20			■		■	■
Construction paper	30 sheets					■	■
Electrical mystery box box (buzzer)	5			■			■
Foam cup	8					■	■
Large-diameter straw	90					■	■
Literacy Reader: *Energy Works* (below grade level)*	1	■	■	■		■	
Literacy Reader: *Energy Works* (on grade level)*	1	■	■	■		■	
Mini lightbulb	20			■		■	■
Marble	40		■		■		■
Medicine cup, 1.25 oz	48					■	■
Motor with attached wires	5			■		■	■
Pair of wire strippers	1			■		■	■
Ping-Pong ball	15		■				■
Pipet	8				■		
Plastic cup, 9 oz	30			■			■
Plastic cup lid	8					■	■
Plastic spoon	48					■	■
Plastic tank	8				■	■	■
Roll of insulated electrical wire	1 roll			■		■	■
Roll of string	1 roll					■	■
Ruler (with center groove)	16		■		■	■	■
Small-diameter straw (individually wrapped)	60				■	■	
Soil	1 bag			■			
Solar panel with attached wires	5			■		■	■
Thermometer	30			■			■
Wooden dowel	8					■	■

* 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	Lesson 6
Additional materials for energy experiments							■
Art supplies						■	
Assorted items that provide or use energy (e.g., batteries, a radio or TV, a wooden match, a fan, food, a wind-up toy)		■					
Battery-operated toy	1		■				
Chart paper or whiteboard		■		■	■	■	■
Glue or tape	30				Optional		
Marker		■		■	■	■	■
Masking tape						■	■
Paper clip, any size	8					■	
Paper towels					■	■	■
Plastic bottle, 8 or 16 oz	8					■	■
Rock, book, or ball	1		■				
Roll of clear tape	8					■	■
Science notebook	30	■	■	■	■	■	■
Scissors	30				Optional	■	■
Slinky, jump rope, or long string	1				■		
Stapler	8					■	■
Textbook	32		■				■
Timer or access to a wall clock with a second hand (optional)	30					■	
Water					■	■	■

NOTES

Unit Overview: *Energy Works*

Energy is a central idea in science; however, it is a complex and somewhat abstract topic that students may struggle to grasp. *Energy Works* incorporates phenomena and provides opportunities for students to manipulate materials while exploring concepts related to energy. Throughout the series of six hands-on lessons, students study different kinds of energy, the transfers and transformations that occur between them, and how energy is used in the world around them. Inquiry-based investigations encourage students to make claims supported with evidence and reasoning, elaborate upon their observations, and design their own experiments.

Students begin by tracing the flow of energy that comes into their bodies and identifying other sources of energy around them. They learn about the two main types of energy—stored (potential) and motion (kinetic)—and participate in interactive demonstrations to draw comparisons between them. To understand the concept of energy transfers and transformations, students set up circuits. They also learn about waves as more than just a water-related topic by examining energy patterns and making connections to forms of communication, like Morse code. Nonrenewable and renewable energy sources are introduced and students explore the benefits and detriments of different types of alternative energy. Students create models of wind turbines and waterwheels and elaborate upon their functionalities. In the last lesson, students design an experiment to answer a question about energy and demonstrate their knowledge. As a culmination, students evaluate how much they have learned about energy by revisiting their pre-unit assessment activity.

Credit: Ulrich Mueller/Shutterstock.com

Next Generation Science Standards

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

Performance Expectations

- **4-PS3-1:** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- **4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- **4-PS3-3:** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- **4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- **4-PS4-1:** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
- **4-PS4-3:** Generate and compare multiple solutions that use patterns to transfer information.
- **4-ESS3-1:** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- **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.
- **3-5-ETS1-3:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Disciplinary Core Ideas

- **PS3.A:** Definitions of Energy
- **PS3.B:** Conservation of Energy and Energy Transfer
- **PS3.C:** Relationship Between Energy and Forces
- **PS3.D:** Energy in Chemical Processes and Everyday Life
- **PS4.A:** Wave Properties
- **PS4.C:** Information Technologies and Instrumentation
- **ESS3.A:** Natural Resources
- **ETS1.A:** Defining Engineering Problems
- **ETS1.C:** Optimizing the Design Solution

Science and Engineering Practices

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

Crosscutting Concepts

- Patterns
- Cause and Effect
- Energy and Matter

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.

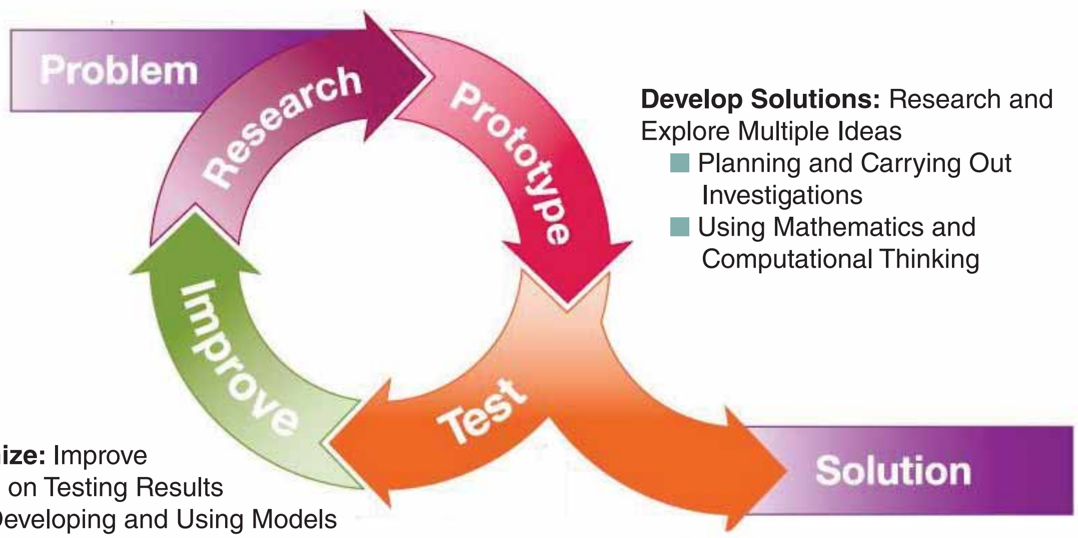
Through scientific engineering and design, students apply what they have learned to creatively solve real-world problems. This 21st-century skill encourages students to collaborate and exposes them to the idea that one problem can have multiple solutions.

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 create a model, develop an experiment, or redesign 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.

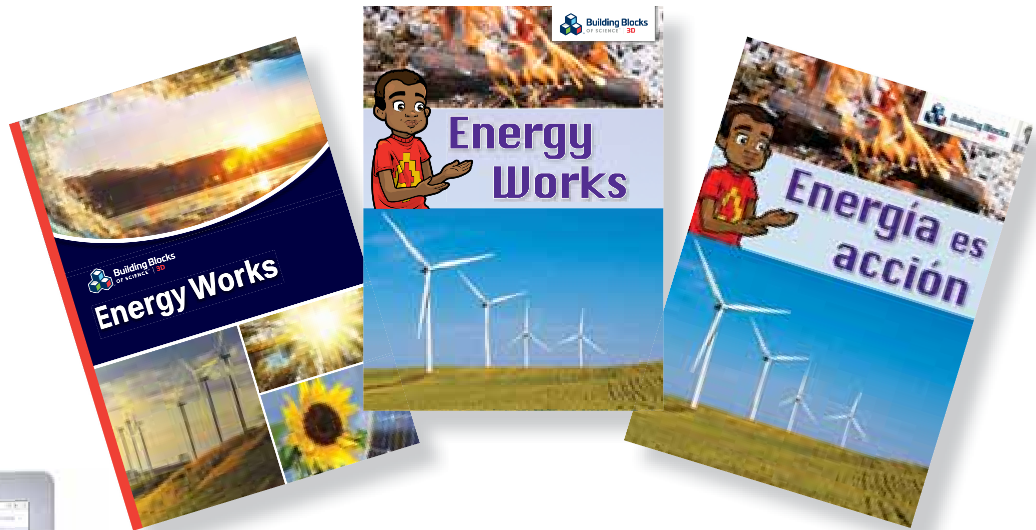
- **General Rubric:** Appendix A includes a rubric that provides an **expected progression of skills and understanding** of science content. You can use these guidelines to assess students throughout the course of the unit.

- **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.

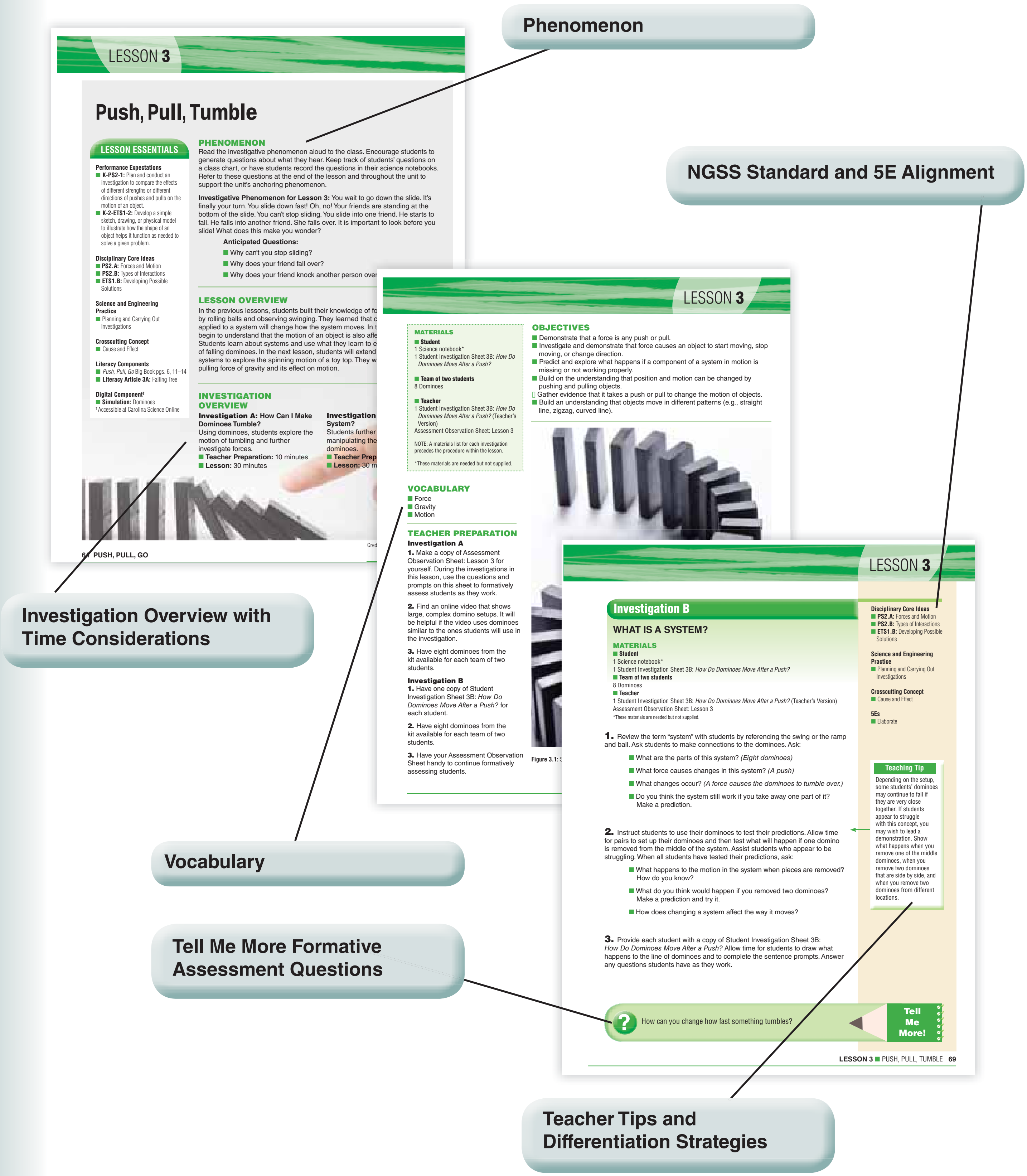
Building Blocks of Science 3D—The Total Package

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



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: Patryc

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.

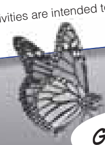
Take-Home Science is an exciting part of our program because it's one way we can better connect home and school. With everyone working together, we can reinforce the science concepts that your student is exploring in the classroom. Here's how Take-Home Science works.

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

Energy Works

Unit Overview

Energy is a central idea in science; however, it is a complex and somewhat abstract topic that students may struggle to grasp. *Energy Works* incorporates phenomena and provides opportunities for students to manipulate materials while exploring concepts related to energy. Throughout a series of six hands-on lessons, students study different kinds of energy, the transfers and transformations that occur between them, and how energy is used in the world around them. Inquiry-based investigations encourage students to make claims supported with evidence and reasoning, elaborate upon their observations, and design their own experiments.

Unit Anchoring Phenomenon

Before batteries, electricity, or even humans existed, many kinds of energy already existed on Earth. However, no type of energy, or life as we know it, would be possible without the Sun. The anchoring phenomenon for *Energy Works* is recognizing the Sun as Earth's ultimate source of energy.

	LESSON 1	LESSON 2
INVESTIGATIVE PHENOMENA	Before a race, coaches tell their runners to eat a healthy meal of pasta, fruits, or vegetables. In fact, coaches of all sports encourage their athletes to have a snack before a game. You might have had a teacher encourage you to eat a good breakfast the morning of a big test. What does this make you wonder?	Rockfalls occur when pieces of rock fall from the side of a steep cliff. They occur most commonly after rain, snowfall, or other types of precipitation. Sometimes high winds play a role in rockfalls. What does this make you wonder?
OBJECTIVES	■ Create a working definition of the term "energy." ■ Identify the Sun as the source of most energy on Earth. ■ Understand that energy can change type. ■ Recognize different types of energy in the classroom.	■ Recognize that energy has many types. ■ Participate in activities that demonstrate the difference between stored energy and motion energy. ■ Demonstrate an understanding of stored energy and motion energy. ■ Recognize that when objects collide, energy is transferred between them.
SCAFFOLDING Students should know:	↓ Energy flows through a system and can change type. ↓ There are different types of energy that can be found in different objects, both living and nonliving.	↓ Energy in a system can exist as stored (potential) energy. ↓ Energy can flow through a system as motion (kinetic) energy. ↓ There are different forms of energy, which can relate to either stored or motion energy. ↓ Speed and energy are related.

Concepts build from one lesson to the next

LESSON 3	LESSON 4	LESSON 5	LESSON 6
You are sitting outside on a very hot day. After some time, you begin sweating and notice that your skin has darkened. You move to a shady area beneath a tree, where it feels cooler. While you sit, you notice that some of the plants around you are smaller than the plants in the sunlight. What does this make you wonder?	Over the course of history, armies have used a device called a heliograph to communicate over long distances. Using a mirror, soldiers use the sunlight to flash patterns that represent letters and numbers. What does this make you wonder?	Some devices and machines are equipped with solar panels. During periods of sunshine, these solar panels absorb the light energy from the Sun and transform it into other types of energy. Newer types of solar panels have the ability to store energy for later use. What does this make you wonder?	In addition to using more renewable energy, we are constantly looking for new ways to develop energy-efficient machinery. Every day, engineers are designing new products that require less energy to function. A few examples include solar-powered charging stations, motion-sensing lights, and LED lights, which are found in many new TVs and car lights. What does this make you wonder?
■ Describe some basic types of energy including light, radiant, thermal, sound, electrical, chemical, and mechanical. ■ Use scientific equipment to investigate energy and how it is transformed into other types and transferred within a system. ■ Model energy transformations using pie charts and provide evidence for energy changes.	■ Identify and define waves as regular patterns of motion. ■ Identify the parts of a wave. ■ Collect evidence to prove that waves have energy. ■ Use patterns to identify waves with different sizes and frequencies. ■ Use evidence to prove that waves can transfer energy.	■ Learn about alternatives to fossil fuels: solar energy, geothermal energy, wind energy, water energy, and biomass energy. ■ Construct models to demonstrate energy. ■ Work cooperatively and follow directions. Suggest innovations in design. Record questions for further exploration.	■ Design and plan an experiment or demonstration to answer a student generated question about energy. ■ Execute a plan to construct apparatus, collect data, and draw conclusions. ■ Present findings of investigations and share results with classmates. ■ Complete self-assessments to evaluate progress.
↓ Energy in a system can be transferred to other objects or transformed into different types of energy. ↓ Circuits demonstrate energy transformations and transfers by creating a closed or open system.	↓ Energy can flow in waves, which follow a pattern. ↓ Light, sound, and water move in waves. ↓ Wave energy can be transferred to different objects. ↓ Changing the energy of a wave will change its shape.	↓ Most of our energy systems rely on fossil fuels, which are nonrenewable. ↓ Alternative, renewable sources of energy can be used to provide energy to systems. ↓ Each kind of alternative energy has pros and cons. ↓ Wind and water energy are affected by speed.	↓ Energy systems rely on energy transfers and transformations in a system to do work, create change, or cause motion. ↓ The total energy in a system can be changed with greater energy input. ↓ Energy is required for life to exist and can be observed everywhere.

NGSS correlations by lesson

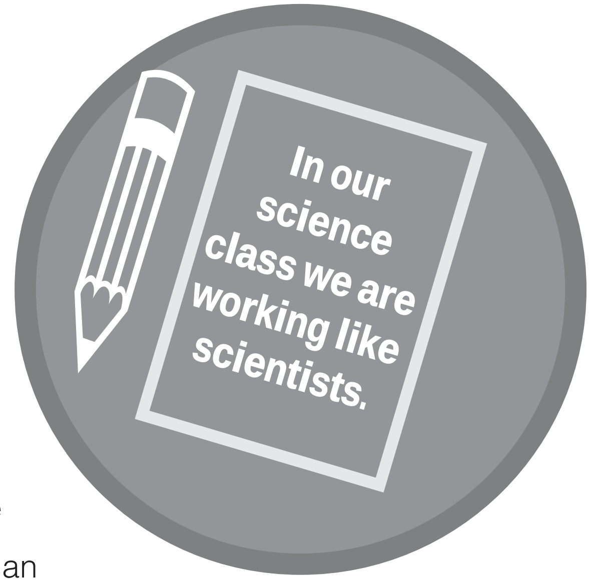
Lesson 2: Stored and Motion Energy

Investigation Overview	Standards	Resources
Investigation A: What Are Stored and Motion Energy? **5Es:** Engage Through classroom demonstrations, students develop definitions "stored energy" and "motion energy." ■ **Teacher Preparation:** 20 minutes ■ **Lesson:** 30 minutes **Tell Me More!** In your own words, define "stored energy" and "motion energy." Use an example to describe each term, and draw a labeled diagram to support each example. Write one question you have about motion energy or stored energy. **Investigation B: How Can I Change the Energy in a Ping-Pong Ball?** **5Es:** Explore, Explain Students drop Ping-Pong balls and make claims about their energy. ■ **Teacher Preparation:** 10 minutes ■ **Lesson:** 30 minutes **Tell Me More!** True or false: When an object's speed changes, so does its energy. Using evidence from your investigation, explain your claim. **Investigation C: What Happens When Objects Collide?** **5Es:** Explore, Explain, Elaborate Students use marble collisions to identify energy transfers. ■ **Teacher Preparation:** 10 minutes ■ **Lesson:** 30 minutes **Tell Me More!** If you park your car in the sunlight for a long time, the seats might become very hot. Explain this in terms of energy transfer.	**Next Generation Science Standards Performance Expectations** ■ **4-PS3-1:** Use evidence to construct an explanation relating the speed of an object to the energy of that object. ■ **4-PS3-3:** Ask questions and predict outcomes about the changes in energy that occur when objects collide. ■ **3-5-ETS1-3:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. **Disciplinary Core Ideas** ■ **PS3.A:** Definitions of Energy ■ **PS3.B:** Conservation of Energy and Energy Transfer ■ **PS3.C:** Relationship between Energy and Forces ■ **ETS1.C:** Optimizing the Design Solution **Science and Engineering Practices** ■ Asking Questions and Defining Problems ■ Developing and Using Models ■ Constructing Explanations and Designing Solutions **Crosscutting Concepts** ■ Cause and Effect ■ Energy and Matter **Language Arts and Math Standards** **Language Arts** **L.4.4:** Vocabulary Acquisition and Use **L.4.6:** Vocabulary Acquisition and Use **RI.4.7:** Integration of Knowledge and Ideas **RI.4.9:** Integration of Knowledge and Ideas **SL.4.1:** Comprehension and Collaboration **W.4.1:** Text Type and Purposes **W.4.2:** Text Type and Purposes **Math** **4.MD.A.2:** Solve problems involving measurement and conversion of measurements.	**Student Investigation Sheets** ■ Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* ■ Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* ■ Student Investigation Sheet 2C: *What Happens When Objects Collide?* **Literacy Components** ■ *Energy Works* Literacy Reader, pgs. 6–9 ■ Literacy Article 2A: Do You Have the Energy for Downhill Mountain Biking? **Digital Components** ■ Interactive Whiteboard: Exploring Stored and Motion Energy ■ Simulation: Stored and Motion Energy ■ Simulation: Ping-Pong Ball Energy ■ Simulation: Energy Transfer **Vocabulary** ■ Motion (kinetic) energy ■ Stored (potential) energy

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

Stored and Motion Energy

LESSON ESSENTIALS

Performance Expectations
- **4-PS3-1:** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- **4-PS3-3:** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- **3-5-ETS1-3:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Disciplinary Core Ideas
- **PS3.A:** Definitions of Energy
- **PS3.B:** Conservation of Energy and Energy Transfer
- **PS3.C:** Relationship between Energy and Forces
- **ETS1.C:** Optimizing the Design Solution

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

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

Literacy Components
- *Energy Works* Literacy Reader, pgs. 6–9
- **Literacy Article 2A:** Do You Have the Energy for Downhill Mountain Biking?

Digital Components‡
- **Interactive Whiteboard:** Exploring Stored and Motion Energy
- **Simulation:** Stored and Motion Energy
- **Simulation:** Ping-Pong Ball Energy
- **Simulation:** Energy Transfer

‡ Accessible at Carolina Science Online

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 provide support for the unit's anchoring phenomenon.

Investigative Phenomenon for Lesson 2: Rockfalls occur when pieces of rock fall from the side of a steep cliff. They occur most commonly after rain, snowfall, or other types of precipitation. Sometimes high winds play a role in rockfalls. What does this make you wonder?

Anticipated Questions:
- Why do rain, snow, and wind cause rockfalls?
- Does the wind blow the rocks off the cliff?
- How fast do the rocks fall?

INVESTIGATION OVERVIEW

Investigation A: What Are Stored and Motion Energy?
Through classroom demonstrations, students develop definitions for "stored energy" and "motion energy."
- **Teacher Preparation:** 20 minutes
- **Lesson:** 30 minutes

Investigation B: How Can I Change the Energy in a Ping-Pong Ball?
Students drop Ping-Pong balls and make claims about their energy.
- **Teacher Preparation:** 10 minutes
- **Lesson:** 30 minutes

Investigation C: What Happens When Objects Collide?
Students use marble collisions to identify energy transfers.
- **Teacher Preparation:** 10 minutes
- **Lesson:** 30 minutes

LESSON OVERVIEW

In Lesson 1, students were introduced to energy by focusing on how energy is stored and moved within their own bodies. In this lesson, students are introduced to the concept that energy can be classified into two broad categories: motion (kinetic) energy and stored (potential) energy. The class participates in several interactive demonstrations that show transformations between stored energy and motion energy, and how stored and motion energy can be transferred between objects, specifically falling and colliding objects. In the next lesson, students will expand their understanding of energy transfers and transformations by building and manipulating circuits.

OBJECTIVES

- Recognize that energy has many types.
- Participate in activities that demonstrate the difference between stored energy and motion energy.
- Demonstrate an understanding of stored energy and motion energy.
- Recognize that when objects collide, energy is transferred between them.

VOCABULARY

- Motion (kinetic) energy
- Stored (potential) energy

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?*
1 Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?*
1 Student Investigation Sheet 2C: *What Happens When Objects Collide?*

Team of two students

1 Ping-Pong ball

Team of four students

2 Marbles
2 Rulers with center groove
4 Textbooks*
Crayons or markers*

Class

1 Battery-operated toy*
1 Rock, book, pencil, or ball*

Teacher

1 Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* (Teacher's Version)
1 Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* (Teacher's Version)
1 Student Investigation Sheet 2C: *What Happens When Objects Collide?* (Teacher's Version)
Chart paper or whiteboard*
Markers (six colors)*

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

*These materials are needed but not supplied.

TEACHER PREPARATION

Investigation A

1. Make a copy of Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* for each student.

3. Gather the materials you will need for the interactive class demonstrations. It is recommended to use a rock and a battery-operated toy. If you cannot access these items, review the demonstration instructions for Investigation A and determine alternative materials you can use.

3. Students will need access to different-colored crayons or markers. Make these available if students do not have their own.

4. Have chart paper or a whiteboard and at least six colors of markers available. Alternatively, you may use Interactive Whiteboard: Exploring Stored and Motion Energy.

Investigation B

1. Make one copy of Student Activity Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* for each student.

Credit: nik7ch/Shutterstock.com

2. Have available from the kit one Ping-Pong ball for each pair of students.

Investigation C

1. Make one copy of Student Investigation Sheet 2C: *What Happens When Objects Collide?* for each student.

2. Have available from the kit two marbles and two rulers for each group of four students. Determine how the materials will be distributed.

3. It is recommended each group use four textbooks to create a base for its ramp. You may choose to provide other materials for groups to use as the bases for the ramps.

Just-in-time background information

BACKGROUND INFORMATION

There are many types of energy, such as chemical, electrical, thermal, light, mechanical, and nuclear. These types are classified into two forms of energy: stored (potential) energy and motion (kinetic) energy.

Potential energy may be thought of as the stored energy present in an object due to its position or condition. This **stored energy** has the capacity, or potential, to do work or cause change. For example, if you lift a ball above your head, the ball has the potential to move once you let it go. The energy the ball has is based on its position above the ground. Once you let the ball go, the stored energy is transformed into **motion (kinetic) energy** as it falls to the ground.

In several investigations, students will examine energy transformation by dropping objects; by doing so, they come to recognize that the amount of energy stored in an object increases with the object's height. Forces are not a focus of this unit, but students may ask about the pulling force of gravity. Objects of the same weight and size will have more motion energy when dropped from a higher position than when dropped from a lower position. Students should be able to understand this concept without having to discuss gravitational potential (stored) energy.

One practical application of energy transformation is the generation of hydroelectricity. There is a huge amount of stored energy in the water held behind a dam. As the water is released, its stored energy is transformed to motion energy that does work to turn turbines that generate electricity.

Examples of both stored and motion energy are easy for students to spot once they become aware of the differences. For instance, there is stored energy in everyday items such as rubber bands, springs, batteries, food, and musical instruments. Motion energy may be witnessed in natural phenomena such as flowing water, tides, precipitation, and blowing winds.

Students also learn to identify energy transfers, which describe the movement of energy within a system. Throughout this unit, the terms "transform" and "transfer" will be used frequently. It is important that you clarify the differences between these terms and use them appropriately to avoid misconceptions. Energy is transformed when the kind of energy changes. For example, when an object goes from a resting position to a moving position, stored energy is transformed into motion energy. Energy is transferred when it moves between objects. For example, when an object falls into water, that object transfers some of its energy into the water and creates waves.

3-Dimensional alignment

Investigation A

WHAT ARE STORED AND MOTION ENERGY?

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?*
Crayons or markers*

Teacher

1 Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* (Teacher's Version)
1 Battery-operated toy*
1 Rock, book, pencil, or ball*
Chart paper or whiteboard*
Markers (six colors)*

*These materials are needed but not supplied.

1. Explain that all objects have energy. Introduce the concept that there are two main forms of energy: stored energy and motion energy. Ask students to think about what each of these terms means and to write a brief definition of each in their science notebooks.

2. Tell the class that they will participate in two interactive demonstrations that will help them understand the difference between stored and motion energy. Explain that energy can transform into different kinds of energy, such as light to chemical energy. Energy can also be transferred, or passed, between objects when they interact, such as when two balls collide. Distribute a copy of Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* to each student, and direct their attention to Demonstration #1: Object Falls from a Mountaintop.

Teaching Tip

Any change in the kind of energy is considered an energy transformation. It is important that you describe changes between stored and motion energy as "transformations." When energy moves between objects, such as a when a hand pushes an object off a table, it is transferred. Energy transfers will be discussed in more detail later.

3. Perform Demonstration #1: Object Falls from a Mountaintop for the class. Use a rock, book, pencil, or ball for your object.

a. Place the chosen object on the edge of a table. Ask students to imagine that this object is perched on a mountaintop. Explain that the object has stored energy. Ask:

- What do you notice about the object's position? *(It is above the ground and has a chance of falling off the table.)*
- What do you think stored energy is? *(Answers will vary.)*
- Does this object have stored or motion energy? *(Stored energy)*

Disciplinary Core Ideas
- **PS3.A:** Definitions of Energy
- **PS3.B:** Conservation of Energy and Energy Transfer

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

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

5Es
- Engage

Literacy Components
- *Energy Works* Literacy Reader, pgs. 6–7
- **Literacy Article 2A:** Do You Have the Energy for Downhill Mountain Biking?

Digital Component
- **Simulation:** Exploring Stored and Motion Energy

Differentiation Strategy

Throughout this unit, "potential energy" will be referred to as "stored energy," and "kinetic energy" will be referred to as "motion energy." Depending on the ability levels of your students, you may wish to increase rigor by using the scientific terms to describe the two forms of energy.

Differentiation

Teaching Tip

Pie charts will be used throughout this unit as models of energy transformation and transfer. Explain to students that the space inside the chart represents 100 percent of the energy in a system.

ELA connection RI.4.7

b. Draw a pie chart on chart paper or on the whiteboard and label it "Object at Rest." Choose one color marker to represent stored energy; create a key to identify the color as stored energy. Completely fill in the pie chart with this color.

c. Explain that the object has only stored energy. Direct students to fill in the first pie chart under Demonstration #1: Object Falls from a Mountaintop on Student Investigation Sheet 2A.

d. Have a student knock the object over the edge. Explain that when the object is falling (moving), it experiences motion energy. Ask:

- When the object was knocked over, what happened to its energy? *(The energy was transformed from stored to motion energy.)*
- The push that knocked the object over the edge was a force. Describe how this models an energy transfer. *(The energy of the force, or push, was transferred into the object. Make sure students understand that this is not a transformation because the type of energy [mechanical] did not change.)*
- What evidence do we have that the form of energy changed? *(The object was still but began moving.)*
- What are the parts of this energy system? *(The object, gravity, and the push, or force, that started the object falling.)*

e. Draw a second pie chart below the first one you drew and label it "Object Falling." Choose a second color to represent motion energy and add it to the key. Fill in about half of the second pie chart with the new color to represent motion energy. Fill in the other half with the color you used for stored energy. Refer to Figure 2.1 for an example. Ask:

- How is this pie chart different from the first? *(Students should see that rather than representing only stored energy like the first chart, this chart represents half motion energy and half stored energy.)*
- What does this pie chart tell us about the energy of the object? *(As the object falls, it has both stored and motion energy.)*
- How does the energy of the object change as it falls? *(The object's stored energy turns into motion energy.)*

f. Draw a third pie chart on the whiteboard and label it "Object Just Before It Collides with Floor." Instruct students to fill in the pie chart on Student Investigation Sheet 2A titled "Object Just Before It Collides with Floor" to show the amounts of stored energy and amount of motion energy they think should be represented at the moment just before the object collides with the floor. When they have filled in the pie chart, prompt students to discuss the question on the investigation sheet with a partner, and then to record their ideas. After some time, ask:

- How did this demonstration show evidence of energy transformation? *(Encourage students to describe the pie charts using the terms "stored energy," "motion energy," "system," and "energy transformation.")*
- What other questions do you have about energy in this demonstration?

g. Summarize the demonstration by explaining that all objects have stored energy. As the height of an object increases (or as its distance from the ground increases), its stored energy also increases. When a force was applied to the object, energy was transferred, causing the object to fall, and its stored energy was transformed to motion energy. Use Figure 2.1 to illustrate these concepts for students.

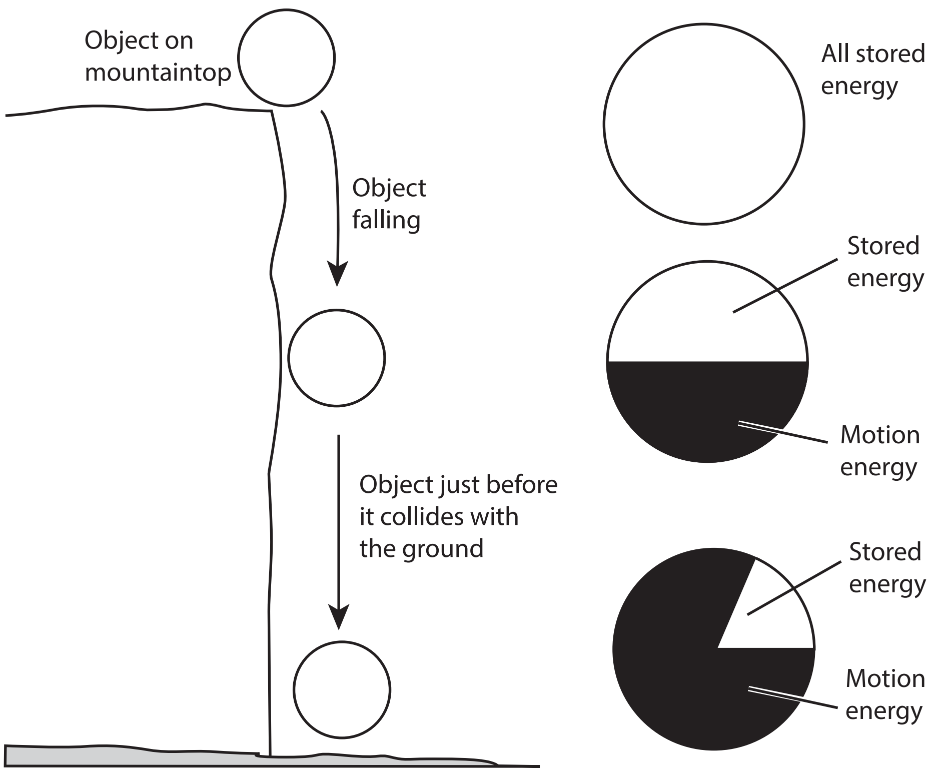


Figure 2.1: Pie charts showing energy transformation as an object falls from a height.

4. Perform Demonstration #2: Battery-Operated Toy for the class.

a. Show students the battery from the toy. Ask:

- There are chemicals inside a battery. When the battery is not connected to the toy, where is the energy stored? *(Energy is stored in the battery's chemicals.)*
- Predict how the energy will change if the battery is put inside the toy. *(How the energy will change depends on the type of toy you are displaying. Students may say that the toy will turn on or that nothing will happen.)*

b. Put the battery inside the toy and display it again for students to observe. Ask:

- Can we consider this toy a system? Why or why not? *(Yes, the toy is a system because there is an energy input [the batteries] and there will be an energy output if the toy is turned on.)*

Teaching Tip

Students may struggle to understand the difference between motion energy and mechanical energy. Explain that motion energy is a form of energy, while mechanical energy is a type of energy. Use the example of an arrow being drawn on a bow. Energy is being stored in the bow and in the arrow as mechanical energy. If the bow is released, the stored energy in the bow transforms into motion energy, which is seen as mechanical energy as the bow string snaps. Some energy is transferred into the arrow as well; this energy is displayed as mechanical energy as the arrow flies toward the target.

Literacy Tip

Ask students to read Literacy Article 2A: Do You Have the Energy for Downhill Mountain Biking? for deeper context for stored and motion energy, and encourage students to make connections to phenomena.

- What form of energy is currently present in this system? *(Stored energy)*
- What evidence proves there is stored energy in the system? *(The toy has a battery that contains chemicals.)*

c. Demonstrate how the toy operates. Instruct students to observe the toy and identify the types of energy present in the system. Direct students to work with a partner to create a key, fill in the pie charts, and answer the question for Demonstration #2 on Student Investigation Sheet 2A.

d. As a class, review students' pie charts and their answers to the question. Make sure that students can identify the types of energy present and use the correct terminology to describe the transformation from stored to motion energy. Encourage them to cite evidence from the demonstrations.

5. Invite students to ask questions about the concepts of stored or transformed energy. If needed, spend time reviewing pie charts.

Digital Tip

As an additional demonstration, use the Stored and Motion Energy simulation. Guide students to manipulate conditions and observe the effects on stored and motion energy.

Literacy integration

Formative assessment

Tell Me More!

In your own words, define "stored energy" and "motion energy." Use an example to describe each term, and draw a labeled diagram to support each example. Write one question you have about motion energy or stored energy.

Investigation B

HOW CAN I CHANGE THE ENERGY IN A PING-PONG BALL?

ELA connection SL.4.1

MATERIALS

- **Student**

1 Science notebook*
1 Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?*

- **Team of two students**

1 Ping-Pong ball

- **Teacher**

1 Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* (Teacher's Version)

*These materials are needed but not supplied.

1. Hold up a Ping-Pong ball. Challenge students to describe the energy in the Ping-Pong ball. Ask:

- When does a Ping-Pong ball have stored energy? *(The Ping-Pong ball has stored energy when it is held in the air.)*
- What could you do to demonstrate the transformation of stored energy to motion energy using a Ping-Pong ball? *(Drop the Ping-Pong ball.)*
- What evidence can we use to identify that energy is being transformed? *(The Ping-Pong ball falls, so its stored energy transforms to motion energy.)*

2. Distribute a copy of Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* to each student. Instruct students to work in pairs to complete Part A of the investigation sheet by identifying the form of energy represented by each picture as stored energy or motion energy.

3. Review stored energy and motion energy by reviewing the answers for Part A of the investigation sheet. Ask students to identify the form of energy in each picture and explain the differences between the pictures in each pair.

4. Direct students to Part B of Student Investigation Sheet 2B. Allow time for students to work in pairs to answer the questions in this section while you distribute a Ping-Pong ball to each pair.

5. Ask pairs to make a prediction about how the energy in the Ping-Pong ball will transform when it is dropped. All students should complete Part C of Student Investigation Sheet 2B. If students struggle to make a prediction, help them set up and complete an "I think… because…." statement.

Disciplinary Core Ideas

- **PS3.A:** Definitions of Energy
- **PS3.B:** Conservation of Energy and Energy Transfer
- **PS3.C:** Relationship between Energy and Forces
- **ETS1.C:** Optimizing the Design Solution

Science and Engineering Practices

- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions

Crosscutting Concepts

- Cause and Effect
- Energy and Matter

5Es

- Explore
- Explain

Literacy Component

- *Energy Works* Literacy Reader, pgs. 6–7

Digital Component

- **Simulation:** Ping-Pong Ball Energy

Digital Tip

Use the Ping-Pong Ball Energy simulation to support the opening discussion about the energy in a Ping-Pong ball when it is dropped.

Differentiation Strategy

To challenge students and gauge their understanding of energy, ask students to identify which type of energy each picture is representing, such as chemical, light, or mechanical.

6. Explain that each pair should develop a plan to investigate their prediction. Direct pairs to write the steps they will follow, including the three heights from which they will drop the ball, in Part D of the investigation sheet. Pairs should also set up a data table in Part E that includes room for all three trials. Allow ample time for this step.

7. Instruct pairs to follow their procedures and to drop their Ping-Pong ball from the three heights they selected. Students should record their observations of each trial in Part E of the investigation sheet.

Teaching Tip

Guide students away from using the terms "faster" or "slower" to describe the motion of the Ping-Pong ball. The relationship between speed and energy will be discussed in the next investigation.

8. When each pair has completed all three tests, facilitate a class discussion about energy systems. Ask:

- What types of energy were present in the system? *(Stored, mechanical [motion], sound [motion] energy.)*
- What did you notice when the height of the ball was increased? *(When the ball was dropped from a higher height, the ball had more motion and fell for a longer amount of time than when it was dropped from a lower height.)*
- Did you notice any differences in how the ball bounced when it was dropped from a higher height? *(Students should notice that the ball bounced higher when its initial height was higher.)*

Differentiation Strategy

It is important that students understand that even though the pie charts may appear the same for two systems, the total energy in the system may be different. Whenever students compare systems, encourage them to label, number, or use symbols to identify the system with the most energy.

9. Obtain two Ping-Pong balls from students and hold them at different heights. Ask the class to predict which ball will bounce higher. Drop them simultaneously for the class to observe. Ask:

- Which ball bounced higher? *(The ball that was held higher.)*
- Think about the energy stored in each ball. Was it the same for both? Explain your answer. *(No, the higher ball had more stored energy than the lower ball because the amount of stored energy an object has increases as its height increases.)*
- If the higher ball had more stored energy, how does that explain why it also bounced higher? *(Because the higher ball had more stored energy, more stored energy was transformed into motion energy, which resulted in a higher bounce when the ball collided with the floor. In other words, because there was more energy to begin with, the higher ball had more energy available for its bounce.)*

Make sure students understand that the higher ball had more total energy in its system. Guide students to conclude that as the height of the Ping-Pong ball increased, the stored energy increased; when the ball was dropped, more energy was transformed into motion energy, which resulted in a higher bounce.

Differentiation

10. Instruct students to answer the questions and complete the pie charts in Part F of the investigation sheet. After ample time, summarize the investigation as a class by reviewing the questions and pie charts. Use the following questions to help students explain their findings:

- Was your prediction supported? Why or why not? *(Answers will vary.)*
- What are the parts of this system? *(A Ping-Pong ball, gravity)*
- What kinds of energy were involved in this system? *(Stored and motion energy)*
- How might the height from which the ball is dropped affect the amount of stored energy in the ball? *(As the height of the ball increases, the amount of stored energy increases.)*
- How does this affect the total energy in the system? *(The higher above the floor the ball is, the more energy is stored in the ball. The entire system has more total energy as the height increases.)*

Teaching Tip

Though students are not required to know about gravitational stored energy, above-level learners may benefit from learning about this form of energy. Challenge students to develop a working definition for "gravitational stored energy," which is the amount of stored energy an object has due to its position and the pull of gravity. Make connections to previous investigations.

11. Introduce the concept of making a claim supported with evidence and reasoning. Explain that throughout the unit, students will make claims to answer questions about energy. Evidence to support a claim should come from investigation data or personal experiences; reasoning should cite scientific principles using evidence to justify the claim.

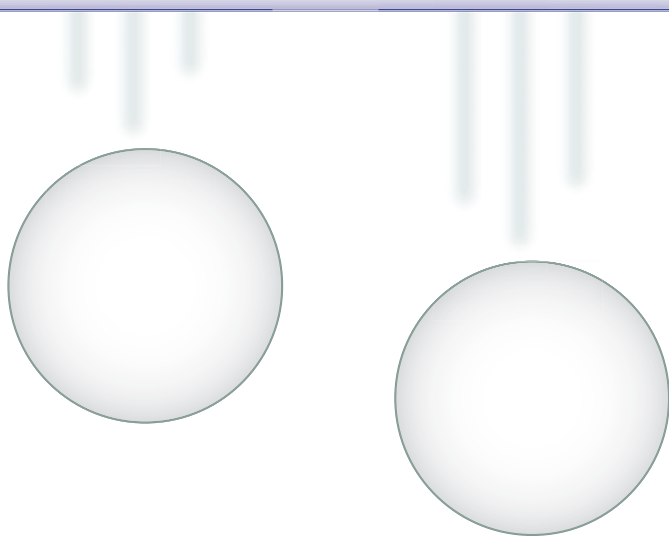
Teaching Tip

Refer to "Sensemaking: Developing Claims Supported with Evidence and Reasoning" in the front of this Teacher's Guide as needed. It is important for students to understand this practice because they will use it throughout the unit.

12. Guide students through making a claim in Part G of Student Investigation Sheet 2B and draw conclusions about energy transformations. Alternatively, allow time for students to complete this on their own. If time allows, review Part G as a class and address any student questions about energy.

Tell Me More!

? True or false: When an object's speed changes, so does its energy. Using evidence from your investigation, explain your claim.



Disciplinary Core Idea
- **PS3.B:** Conservation of Energy and Energy Transfer

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

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

5Es
- Explore
- Explain
- Elaborate

Literacy Component
- *Energy Works* Literacy Reader, pgs. 8–9

Digital Component
- **Simulation:** Energy Transfer

Investigation C

WHAT HAPPENS WHEN OBJECTS COLLIDE?

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 2C: *What Happens When Objects Collide?*

Team of four students

2 Marbles
2 Rulers with center groove
4 Textbooks*

Teacher

1 Student Investigation Sheet 2C: *What Happens When Objects Collide?* (Teacher's Version)

*These materials are needed but not supplied.

1. Prompt students to recall the investigation using Ping-Pong balls. Ask:

- How did energy transform? *(When the Ping-Pong ball was dropped, its stored energy transformed into motion energy.)*
- Was energy transferred in this investigation? *(Answers will vary. Students may mention that mechanical energy was transferred when the ball hit the ground.)*
- What can you infer about the energy in the system as the height of the ball increased? *(The total energy in the system increased.)*

2. Ask students to imagine what would have happened if the Ping-Pong ball was dropped onto another object, like a pencil or another ball. Ask:

- Predict what would happen to the energy in the Ping-Pong ball if it hit another object. *(Answers will vary. Students should recognize that an energy transfer would occur, or that the Ping-Pong ball might lose energy.)*
- What evidence would suggest that energy was transferred? *(If the other object moved.)*

3. Ask the following questions, and instruct students to respond in their science notebooks:

- Define "collision." Provide an example of objects that collide. *(A collision is when two objects come into contact. Examples will vary but include bumper cars, pool balls, or athletes in a football game.)*
- Do both objects need to be moving for a collision to occur? *(No, only one object needs to be moving.)*
- Describe the relationship between collisions and energy transfer? *(When objects collide, they transfer energy.)*

4. Distribute a copy of Student Investigation Sheet 2C: *What Happens When Objects Collide?* to each student. Divide the class into groups of four students, and give each group two marbles, two rulers, and four textbooks. Direct students to Part A of the investigation sheet, and ask them to write a prediction about the movement of the marbles after the collision on a flat surface.

ELA connection SL.4.1

5. Instruct groups to place their marbles about 15 cm apart in the groove of the ruler and then to roll one marble into the other. In their groups, students should make observations and draw a diagram in the box in Part A of the investigation sheet. Students should notice that the stationary marble begins to move when the other marble collides with it. Instruct students to answer the remaining questions in Part A of the investigation sheet.

6. Ask students to make a prediction about the movement of the marbles when one marble rolls down a ramp and collides with a stationary marble. Students should record their prediction in Part B of Student Investigation Sheet 2C.

Digital simulations to enrich concepts

7. Direct each group to use two textbooks and the ruler to build a ramp. They should place one marble on the floor about 15 cm from the end of the ruler but directly in line with the groove of the ruler. Explain that they will roll one marble down the groove to collide with the stationary marble. Students should record their observations and answer the questions in Part B of the investigation sheet.

Digital Tip

Use the Energy Transfer simulation to support the concepts related to this investigation. Encourage students to make predictions about the energy in the system when the height of the ramp changes.

8. Challenge students to consider the energy in the system as the ramp changes. Ask:

- How can you increase the amount of stored energy in the marble? *(Increase the height of the ramp.)*
- Predict how the total energy in the system would change if you made the ramp higher. *(If the ramp were higher, there would be more stored energy in the moving marble due to its starting position at the top of the higher ramp, and so there would be more total energy in the system. More energy would then be transferred to the stationary ball during the collision.)*
- Compare the speed of the marble on the ramp to the speed of the marble on the flat surface. *(The marble on the ramp is moving fast. The marble on the flat surface is not moving. It is still.)*
- Based on their speeds, what can you conclude about the energy of the marbles in this system? *(The marble that is moving has more energy than the marble that is still.)*

9. Students will now observe the changes in energy when two marbles are rolled into each other. Direct each group to build two ramps using two textbooks and one ruler for each ramp. They should position the ramps so that the rulers are directly opposite each other and so that when a marble is rolled down each ramp simultaneously, the marbles will collide. Direct students to make a prediction in Part C of Student Investigation Sheet 2C.

10. Have students roll a marble down each of the opposing ramps to produce a collision. Students should draw a diagram of their observations and answer the questions in Part C of Student Investigation Sheet 2C.

11. Review students' responses to the questions in each part of Student Investigation Sheet 2C. Encourage students to explain if their predictions were supported. Make comparisons between the energy in each of the systems students built, and guide them to describe energy transfers.

Teaching Tip

Students need to understand that energy is never lost or gained in a system. Explain that the marbles slowed down because some of the energy transformed into heat (due to friction) and sound as the marbles collided.

12. Allow time for students to make conclusions in Part D by answering the questions and filling in the pie charts. Review students' responses as a class, and use their pie charts to describe the energy transfers for collisions in all three scenarios.

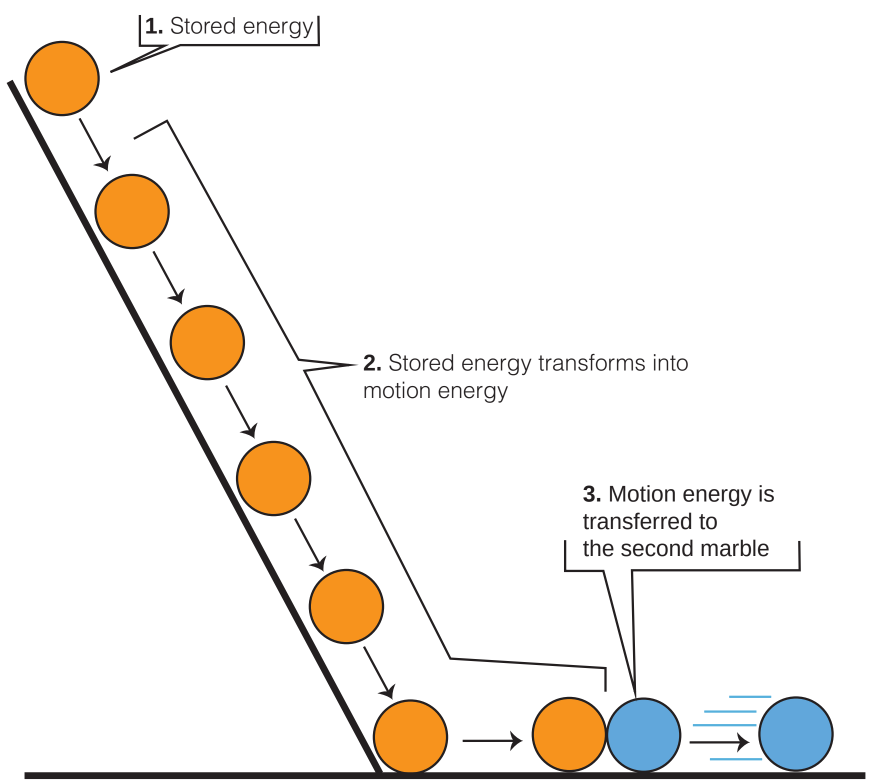


Figure 2.2: Energy transformation and transfer as one marble rolls down the ramp and collides with a second marble.

Tell Me More!

If you park your car in the sunlight for a long time, the seats might become very hot. Explain this in terms of energy transfer.

Phenomenon

Review students' questions about the investigative phenomena from the beginning of this lesson. Guide students in applying the concepts explored in this lesson and connecting them to the anchoring phenomenon: the Sun is Earth's ultimate source of energy. By the end of the lesson, students should be able to explain that:

- When rocks fall, they experience the transformation of stored energy to motion energy.
- The higher the cliff, the more stored energy a rock has before it falls.
- Depending on the force of the wind, loose rocks may be blown off the cliff. Wind occurs as the air heats and cools, cycling in the atmosphere. The Sun is responsible for heating the air.

Connecting ideas about phenomena to evidence

ELA connection L.4.6

Formative assessment—how are they progressing?

EXTENSIONS

Popcorn Energy
Make a batch of popcorn and have students describe popcorn and other types of food in terms of stored and motion energy. Beginning with the energy from the Sun, review the energy transfers and conversions that occur to make popcorn (light, heat, sound). Then ask students how the popcorn provides their bodies with energy.

Credit: tabak lejlav/Shutterstock.com

Ping-Pong Potential—Division Story Problem
Have students work in pairs to solve the following word problem:

The fourth-grade class at Shadow Brook School was working on a science unit on energy. Their teacher, Ms. Burling, took the class to the gym to discover the stored and motion energy of a Ping-Pong game. That day, there were 20 students in class. The gym had 6 tables and a box of 15 balls. How many tables did the class need to use if there were 4 students (2 teams of 2 students) at each table? *(20 ÷ 4 = 5 tables)* How many balls could be given to each table? *(15 ÷ 5 = 3 balls for each table)*

Math connection 4.MD.A2

ASSESSMENT STRATEGIES

1. Investigation A

- Review Student Investigation Sheet 2A: *How Can We Graph Stored and Motion Energy?* to determine students' ability to model energy transformation using pie charts. Make sure students are comfortable with graphing because pie charts will be used to illustrate concepts throughout the unit.

- Use students' responses to the Tell Me More question to assess how well they can define "stored energy" and "motion energy," and to determine any additional questions they may have. If students do not seem to understand these concepts, you may wish to provide supplemental review.

2. Investigation B

- Check Student Investigation Sheet 2B: *How Can I Change the Energy in a Ping-Pong Ball?* to determine if students recognize energy transformations and how total energy changes in a system. Review students' questions about energy.

- Use students' responses to the Tell Me More question to assess if they can make connections between motion energy and speed. If students do not seem to understand this concept, you may wish to provide supplemental review.

3. Investigation C

- Check Student Investigation Sheet 2C: *What Happens When Objects Collide?* to determine whether students can identify and describe energy exchanges that occur when two objects come into contact under different conditions (i.e., one stationary, one moving; both moving).

- Use students' responses to the Tell Me More question to assess if they can identify energy transfers that occur due to the Sun. They should recognize that the car's seats will absorb the thermal energy from the Sun, causing them to heat up.

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

PLANNING AHEAD

Preparing for Lesson 3, Investigation C
The instructional model used in Lesson 3, Part C, is different from previous lessons. Investigation C is designed to have student pairs engaged concurrently in three different activities. Investigation C will take three class sessions; students will complete one of three activities during each class session. Investigation D follows with a whole-class discussion of all three activities and will take place during a fourth class session.

The kit includes enough materials for five teams of two students to work on each activity at one time. Students will collect the materials they need for each activity. It works well to set up a distribution center in an area and leave it set up for several days. Be sure that you make each student one copy of each of the three student investigation sheets. The investigations may be completed in any order as long as all three are completed before moving on to Investigation D.

The corresponding student investigation sheets for each investigation are designed to allow students to work relatively independently. However, it may be necessary to provide additional instruction depending on grade level and prior experience with circuits. Adjust your plan for Investigation C based on the needs of your students.

ELA connection L.4.4, L.4.6, RI.4.7

Name ____________________

Date ____________________

Do You Have the Energy for Downhill Mountain Biking?

You're riding a bike and you come to a large hill. It takes a lot of energy to pedal up the hill, and once you finally make it to the top, you notice how steep the hill is. How much energy will it take to pedal down the hill?

Have you ever heard of a sport called mountain biking? Athletes ride a special kind of bike up a mountain and then race down the mountain. Because they are moving downhill, they do not need to pedal the bike.

Imagine a ball rolling down a ramp. This is similar to how a mountain bike moves down a mountain. A mountain bike can move at speeds from 80 to 113 kilometers (50 to 70 miles) per hour. In February 2017, the world record for downhill mountain biking was 161 kilometers (100 miles) per hour. That's faster than a cheetah can run!

Think about the energy a biker needs for downhill mountain biking. It takes *a lot* of energy for the athlete to pedal the bike to the top of the mountain. It is important for a biker to eat a big meal before they begin a ride. They might even pack snacks.

A mountain biker must be aware of many dangers, like trees, rocks, and holes in the ground. Mountain bikers must wear a lot of protective gear to keep themselves safe, including gloves, elbow pads, and helmets.

If you like roller coasters and riding bikes, then mountain biking might be the perfect sport for you!

Questions:

1. When does a mountain bike experience the most stored energy? The most motion energy? Describe the transformation between these two forms of energy during a mountain biking trip.

2. What types of energy are involved in mountain biking?

3. Create a map of a bike trail that has several hills and valleys. Choose four points along the trail. Mark these locations on the map, and make a pie chart to describe the energy of the bicyclist at each location.

Credit: wavebreakmedia/Shutterstock.com

Student Investigation Sheet 2A

Name ______________________________

How Can We Graph Stored and Motion Energy?

Date ______________________________

For each demonstration, create a pie chart to show the transformation from stored to motion energy. Create a key that identifies each form or type of energy, and then color-code the energy present.

Demonstration #1: Object Falls from a Mountaintop

Energy Present

- ◯ Stored
- ◯ Motion

ELA connection RI.4.7, W.4.2

Object at rest

Object fallling

Object just before it collides with the floor

How did this demonstration show evidence of energy transformation? Is there evidence of energy transfer?

Demonstration #2: Battery-Operated Device

Energy Present

Battery outside of device	Battery inside device (no power)	Battery inside device (with power)

How did this demonstration show evidence of energy transformation? Is there evidence of energy transfer?

Student Investigation Sheet 2B

How Can I Change the Energy in a Ping-Pong Ball?

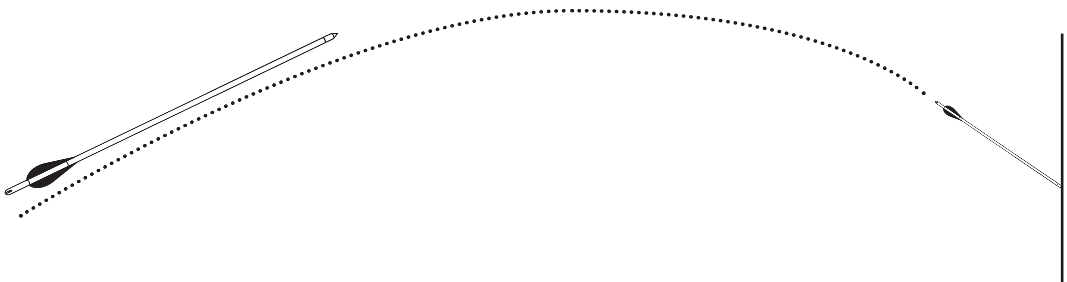
Name ______________________

Date ______________________

Equipment: 1 Ping-Pong ball

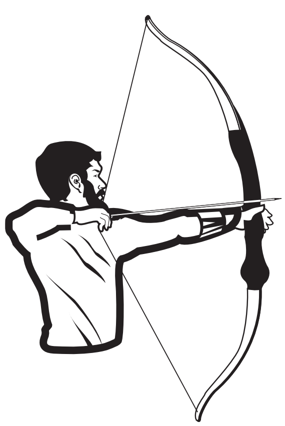
A. Practice

Look at each picture below. Is the energy stored or working? Write “stored” or “motion”(working) on the line below each picture.

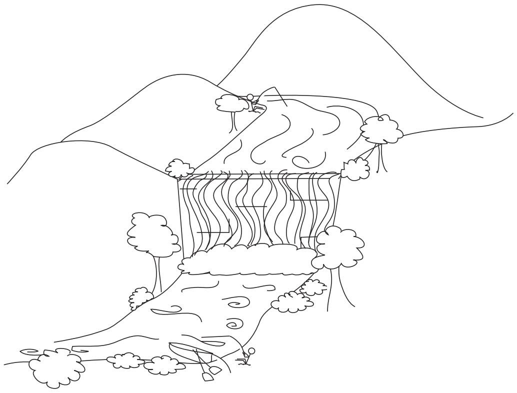


ELA connection L.4.6, W.4.1, SL.4.1

1. ______________________

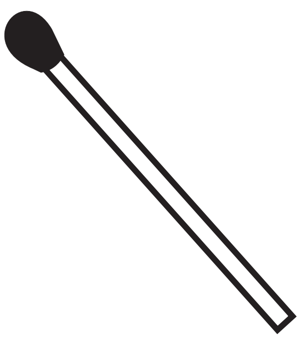


2. ______________________

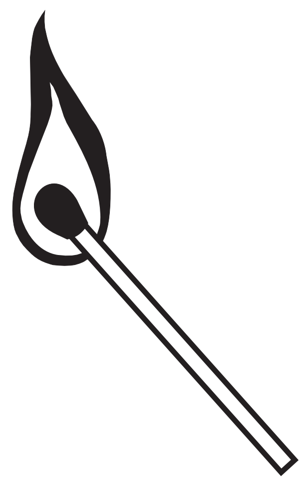


3. ______________________

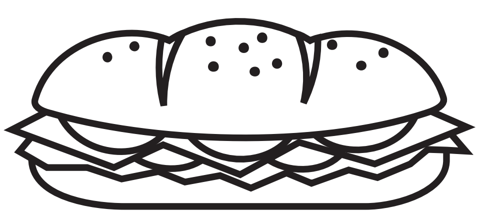
4. ______________________



5. ______________________



6. ______________________



7. ______________________

8. ______________________

B. Think

1. Can a ball store energy?

2. How can a ball transform its stored energy into motion energy?

3. Can you increase the amount of energy stored in the ball? How?

C. Predict

How will the energy in a Ping-Pong ball change when it is dropped from different heights?

D. Plan

Plan an investigation in which you will observe the energy of the Ping-Pong ball as it is dropped from three different heights. Record your procedure, including the heights from which you will drop the ball, in the space below.

E. Observe

Develop a table to record your data and observations about the energy of the ball.

F. Analyze

1. How could you increase the speed of the ball as it falls?

2. Use the space below to draw the Ping-Pong ball falling from two different heights. For each height, draw three pie charts to show the energy of the ball when it is at rest, when it is falling, and just before it collides with the ground. Use a different color to represent each type of energy, and create a key.

3. Circle the drawing above that displays the Ping-Pong ball with the most total energy. Explain your choice.

G. Conclude

1. What can you do to change the energy when dropping a Ping-Pong ball? Make a claim to answer the question. Support your claim with evidence and reasoning from your investigation.

Claim (a statement or conclusion that answers the question you are testing)	
Evidence (data that supports your claim)	**Reasoning** (a justification explaining why your evidence supports your claim using scientific principles)

2. How would the energy of the Ping-Pong ball be different if it was thrown up in the air rather than dropped? Create a series of pie charts to support your ideas.

3. Write one question you have about energy.

Student Investigation Sheet 2C

What Happens When Objects Collide?

Name ______________________________

Date ______________________________

Equipment: 2 Marbles 2 Rulers with center groove 4 Textbooks

ELA connection SL.4.1

A. Flat Surface

1. Predict what will happen when a moving marble collides with a stationary marble on a flat surface.

____

____

____

2. Roll one marble along the groove of the ruler into a second marble. Draw a diagram of what you observe.

3. Was your prediction supported? Use evidence to explain. ______________________________

____

____

4. What evidence suggests that energy was transferred?

B. One Ramp

1. Predict what will happen to a stationary marble when a marble rolls down a ramp and collides with it.

2. Roll one marble down the ramp toward the stationary marble. Draw a diagram of what you observe.

3. Was your prediction supported? Use evidence to explain.

4. What evidence suggests that energy was transferred?

5. How did the energy of this system differ from the energy of the system on a flat surface?

6. Describe the speed of the marbles before the collision and after the collision.

7. Which marble has more energy before the collision?

8. Which marble has more energy after the collision?

C. Two Ramps

1. Predict what will happen when two moving marbles collide.

2. Roll both marbles down their ramps to collide with each other. Draw a diagram of what you observe.

3. Was your prediction supported? Use evidence to explain.

4. What evidence suggests that energy was transferred?

5. How did the energy of the system with two ramps compare to the energy of the systems with a flat surface and one ramp?

6. Make a claim about the total energy in this system, in which both marbles are moving (have speed). Use evidence from your observations to support your claim.

D. Conclude

1. What is the difference between the energy in a stationary marble at the top of a ramp and the energy in a stationary marble on the floor?

2. Consider the energy in the system when one marble was on a ramp and the other was on a flat surface. Use pie charts to compare the energy of the marbles before and after the collision. Provide a brief explanation of any differences in energy.

	Before collision	After collision
Marble on ramp		
Marble on flat surface		

3. When does energy transform in this system? ______________________________

____

____

4. How does energy transfer during a collision? Make a claim to answer the question. Support your claim with evidence and reasoning from your investigation.

Claim (a statement or conclusion that answers the question you are testing)	
Evidence (data that supports your claim)	**Reasoning** (a justification explaining why your evidence supports your claim using scientific principles)

Summative Assessment

Name ______________________

Date ______________________

What have they learned?

1. When an object is held in the air, it has stored energy. When the object is released and begins falling, it experiences __________.

a. electrical energy
b. transferred energy
c. motion energy
d. collision energy

2. Match each appliance below with the energy transformation it performs.

a. Oven	**1.** electrical → sound
b. Blender	**2.** electrical → sound and light
c. Stereo	**3.** electrical → mechanical and sound
d. TV	**4.** electrical → heat

3. Match each action below with the energy transformation that makes it happen.

a. A guitar string vibrates	**1.** chemical → mechanical
b. A wind-up toy moves	**2.** solar → light
c. A streetlight absorbs sunlight during the day and glows at night	**3.** mechanical → sound
d. A tennis player uses food energy to play a match	**4.** mechanical → mechanical

4. A bike, a truck, and a train—all without passengers, motors, or engines—roll down the same hill. Put the vehicles in order from the least amount of motion energy to the most.

(least) ______________ → ____________________ → __________________(most)

5. Consider the scenario in Question 4. Imagine that the truck collides with a stationary car at the bottom of the hill. Which of the following is likely to happen?

a. When the truck and car collide, they move in opposite directions.
b. When the truck and car collide, the car is pushed and begins moving and the truck slowly comes to a stop.
c. When the truck and car collide, the truck rolls over the car and keeps moving.
d. When the truck and car collide, the car does not move and the truck comes to a stop.

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


Energy and Its Forms

What Is Energy?

Energy is the ability to make things move or change. Energy is all around you. Energy allows you to ride a bicycle. It moves trucks and cars along the road. It makes the Moon move around Earth. Energy melts ice. It makes volcanoes erupt. Energy makes plants grow and change.

You can see your friends and hear them speak because of energy. Energy lights homes and schools. It runs televisions and computers. Energy makes things happen.

Light Energy

There are different kinds of energy. They include light, heat, and sound energy. They include electrical, chemical, and mechanical energy.

Light energy is energy that you can see. It moves in waves and enters your eyes so that you can see things. Light energy can come from lamps, fires, or lit candles.

The Sun is the main source of light energy on Earth. Energy from the Sun comes to Earth as sunlight. Plants and animals, including people, depend on this source of energy.

Plants need light energy to grow.

You use energy to make a bicycle move.

2

3

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

Energy Works

Student literacy—available in digital and print

Stored and Motion Energy

The energy of moving things is called **motion energy**, or kinetic energy. All moving things have motion energy. A leaf has motion energy when it falls to the ground. You have motion energy when you run. An airplane has motion energy when it flies.

Moving things with more mass have more motion energy. Faster-moving things have more motion energy. For example, a moving car has more motion energy than a bicycle.

Light, sound, heat, and electrical energy include the motion of waves and particles. They are different types of motion energy.

A skier sliding down a mountain on skis has motion energy.

Stored energy, or potential energy, is energy that is not being used. A parked car has stored energy. The stored energy will be used when the car begins to move. A skier who is standing still has stored energy. The skier's stored energy will turn into motion energy when the skier begins to move.

An object's position can affect its stored energy. The higher an object is, the more stored energy it has. A skier at the top of a mountain has more stored energy than one halfway down the mountain.

ELA connection L.4.4, L.4.6

A skier standing still at the top of a mountain has stored energy.

Energy Transfers

Energy moves and changes all the time. It transfers, or moves, from one object to another.

Light energy from the Sun moves as waves through space to Earth. Heat energy moves out from burning wood in a fire. It moves as waves across a room to your warm hands. Heat also moves from one particle of matter to another when they touch. You pick up a mug of hot milk. Heat moves from the mug to your hands. A dog barks. Sound transfers from the dog's throat to your ears.

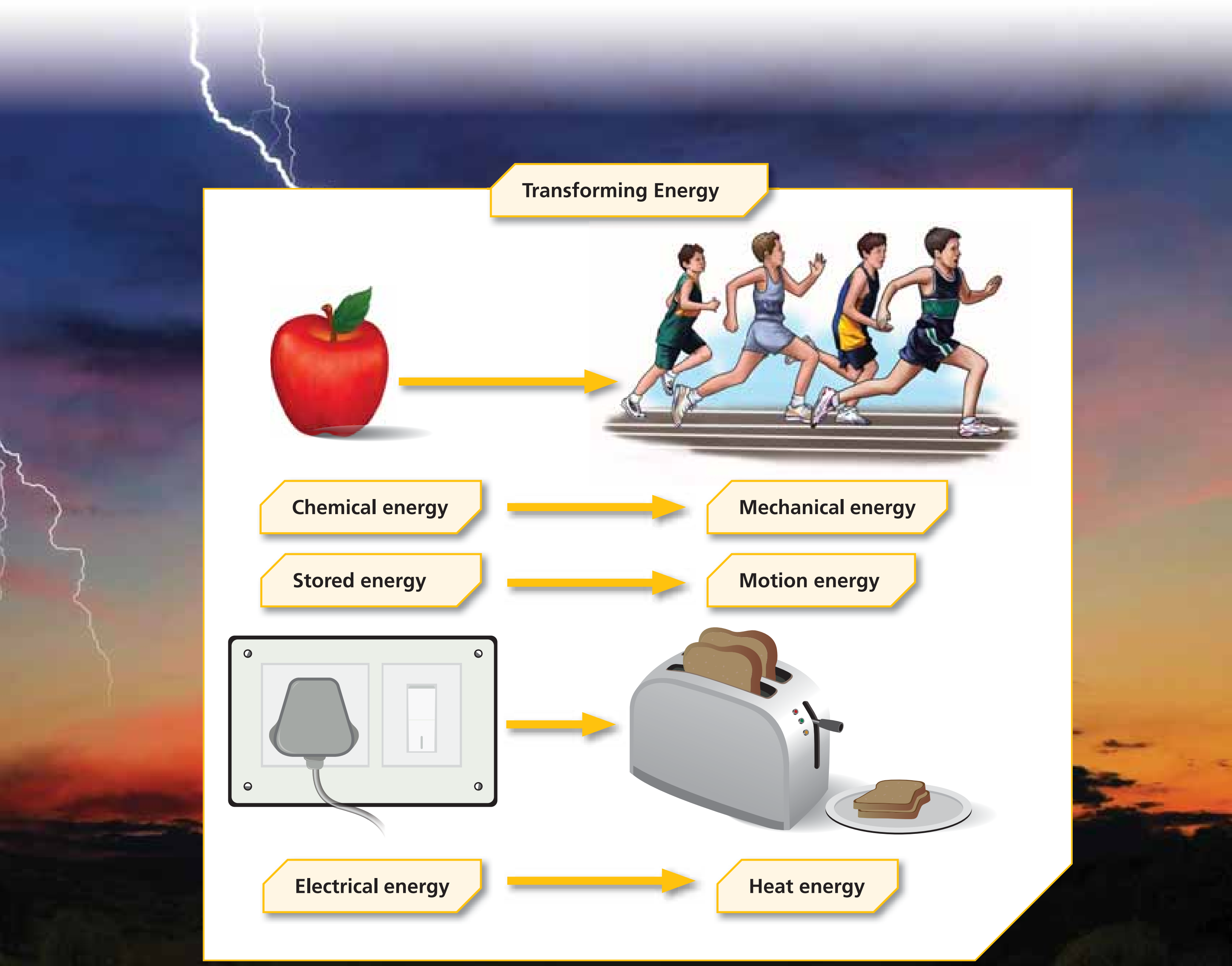
Electrical energy transfers from a cloud to the ground as lightning.

Energy Changes

Energy can convert, or change into, a different type. Chemical energy is stored in wood. When wood burns, that energy transforms into heat and light energy.

You have chemical energy from food stored in your body. When you run, some of this energy transforms into mechanical energy. In other words, you change stored energy to motion energy.

Light energy can transform into heat energy. For example, your body becomes warm when you sit in sunlight. When you use a toaster, electrical energy transforms into heat energy that toasts the bread.



Careers

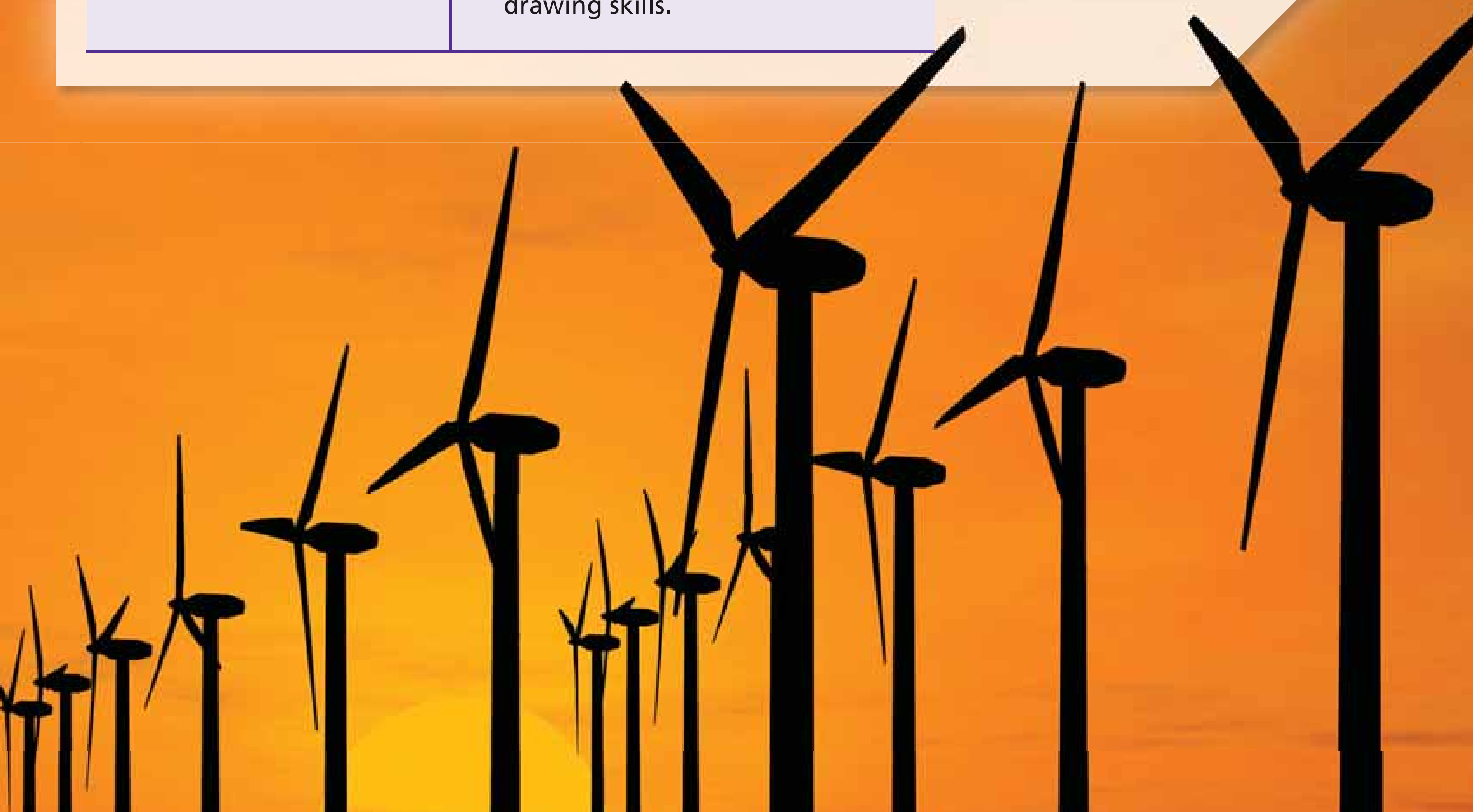
Science in the world

Electrical Engineer

Electrical engineers turn ideas about electrical energy into things people can use. They study how energy moves through matter and changes form. They design and improve wind turbines and solar panels.

This electrical engineer helps improve solar panels.

Would I like this career?	You might like this career if • you like to design new things. • you like to understand how technology works.
What would I do?	• You would study different forms and uses of energy. • You would research how electrical energy is made.
How can I prepare for this career?	• Study science, math, and engineering. • Develop good computer and drawing skills.



Profesiones

Ingeniero eléctrico

Los ingenieros eléctricos convierten ideas acerca de la energía eléctrica en cosas que la gente puede usar. Estudian cómo se mueve la energía a través de la materia y cambia de forma. Diseñan y mejoran las turbinas de viento y los paneles solares.

Esta ingeniero eléctrico ayuda a mejorar los paneles solares.

¿Me gustaría esta profesión?	Te gustaría esta profesión si • te gusta diseñar nuevas cosas. • te gusta comprender cómo funciona la tecnología.
¿Qué tendría que hacer?	• Estudiarías las diferentes formas y usos de la energía. • Investigarías cómo se genera energía eléctrica.
¿Cómo puedo prepararme para esta profesión?	• Estudia ciencias, matemáticas e ingeniería. • Desarrolla buenas destrezas computacionales y de dibujo.

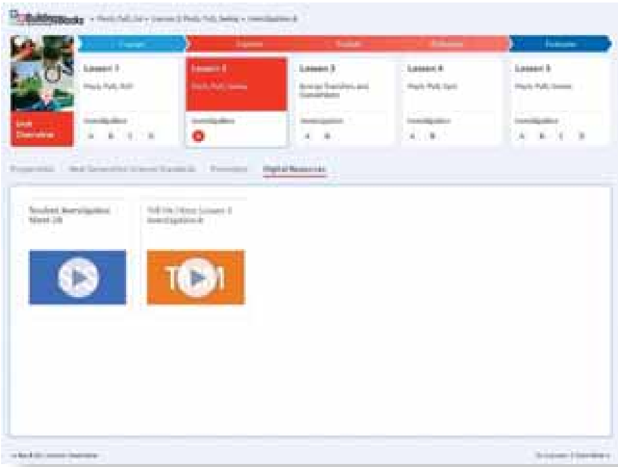
The Right Blend of Hands-On Investigation and Technology

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

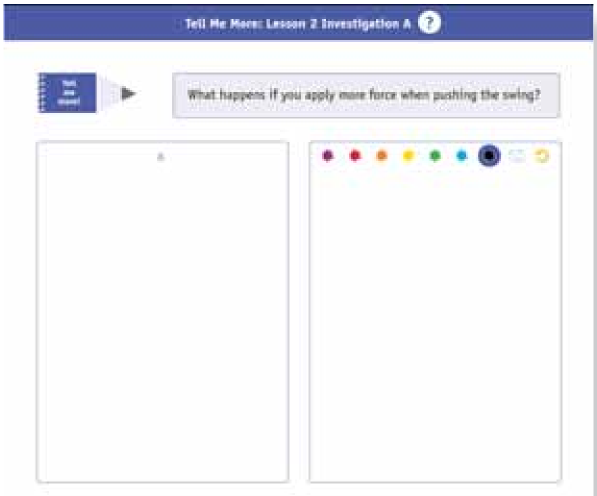
- Identification of where a lesson falls within the **5E Learning Cycle**
- **Preparation**—Includes investigation overview, materials list, and step-by-step teacher preparation instructions
- **NGSS Standards**—Includes the PEs, DCIs, SEPs, and CCCs that will be addressed within the investigation
- **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

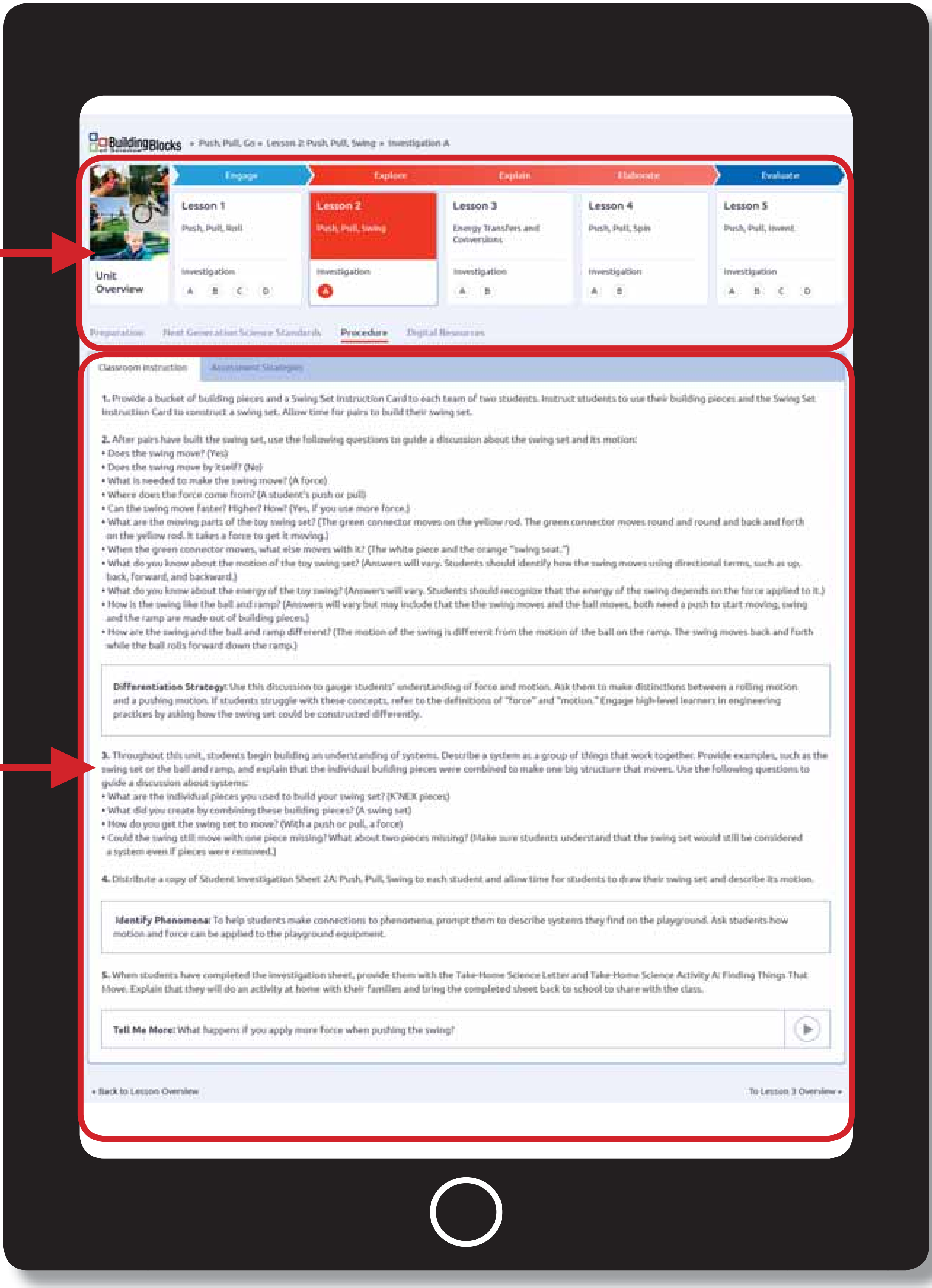
- Step-by-step instruction including guiding questions and anticipated responses
- Differentiation strategies at point of use within each investigation
- **Identify Phenomena** provides teachers with prompts to help students make connections to phenomena addressed within an investigation
- Assessment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

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

Unit Overview

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?

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To Lesson 3 Overview »

Digital Components to Support Instruction and Assessment

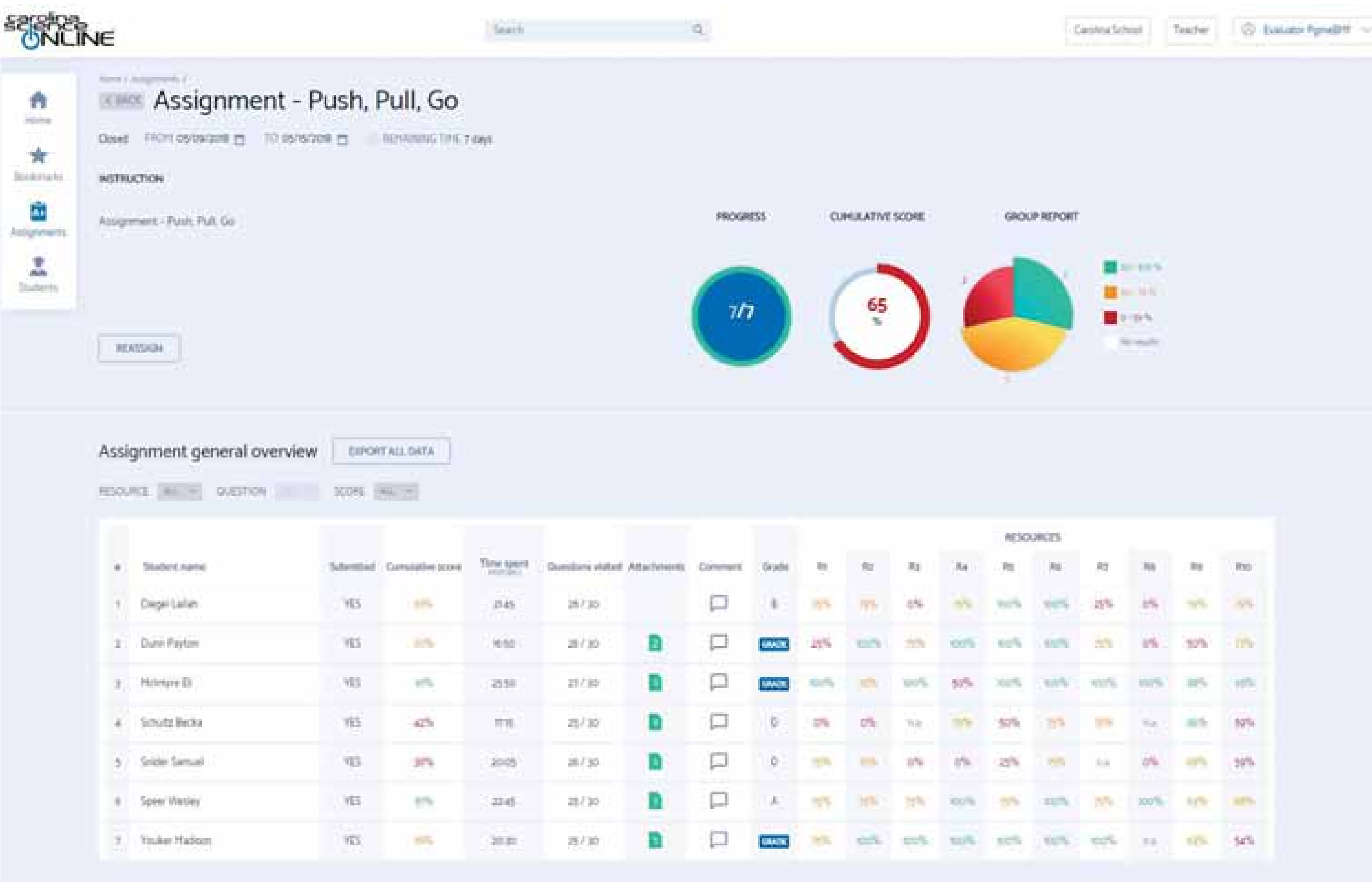
For the Teacher—Customizable Digital Planning at Your Fingertips

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

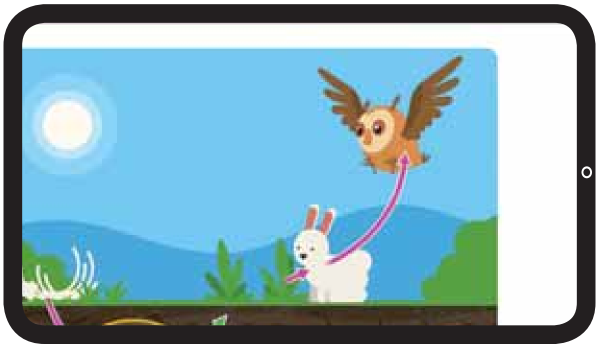
The Assignment management system dashboard allows you to:

- 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.

NOTES

NOTES

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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!

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