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Learning Framework for Grades K–5

Kindergarten	Push, Pull, Go	Weather and Sky	Living Things and Their Needs
1st Grade	Light and Sound Waves	Sky Watchers	Exploring Organisms
2nd Grade	Matter	Earth Materials	Ecosystem Diversity
3rd Grade	Forces and Interactions	Weather and Climate Patterns	Life in Ecosystems
4th Grade	Energy Works	Changing Earth	Plant and Animal Structures
5th Grade	Structure and Properties of Matter	Earth and Space Systems	Matter and Energy in Ecosystems

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18 scaffolded units K–5

Life | Earth | Physical

3 Pre-K units

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Energy Works

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Record questions in your science notebook.

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. Why is this?

What does this make you wonder?

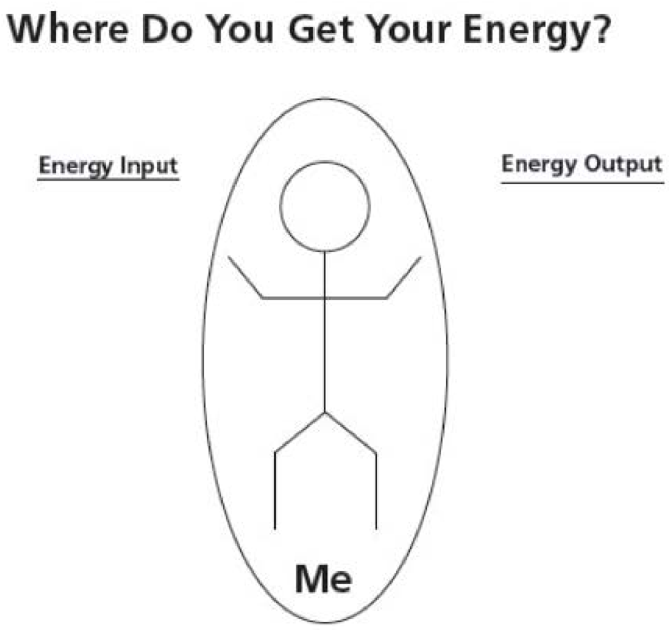
What does this make you wonder?

Lesson 1, Investigation A

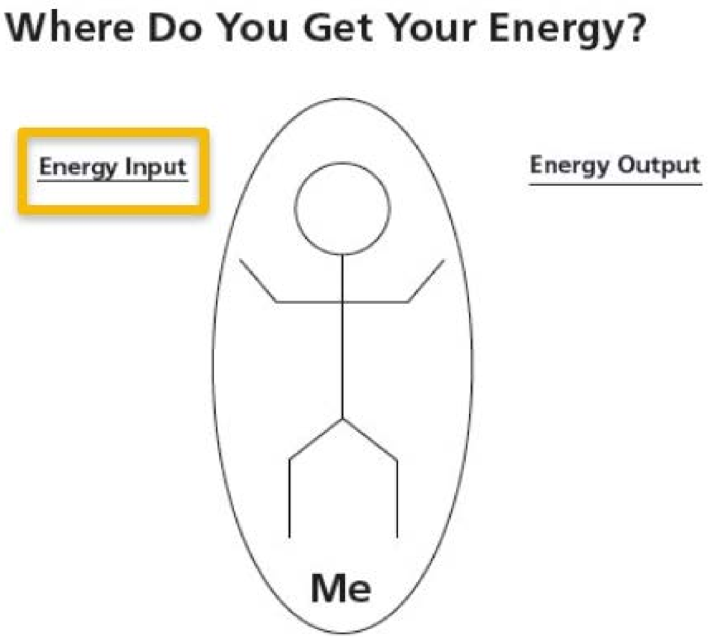
Pre-Unit Assessment: Where Do You Get Your Energy?

- What does it mean when someone says that you have a lot of energy?
- When do you feel like you have the most energy?
- How do you put energy into your body?
- Why does your body need energy?
- What questions do you have about energy in your body?

- The human body is considered an energy system because it takes in energy and uses it to live, grow, and perform activities.
- Identify some sources of energy for your body.
- What are some ways you use the energy you obtain?



- How do animals get energy?
- Can animals be considered energy systems? Why?
- How do plants get their energy?
- Can plants be considered energy systems?



Lesson 1 Investigation A – IWB: Where Do You Get Your Energy?

Spanish

Where Do You Get Your Energy?

Energy Input

Plants

A

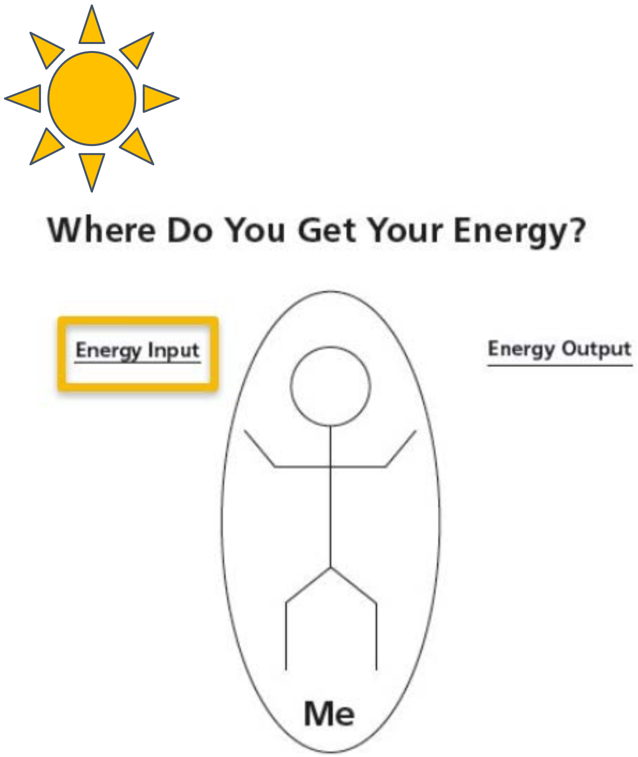
Animal Products

A

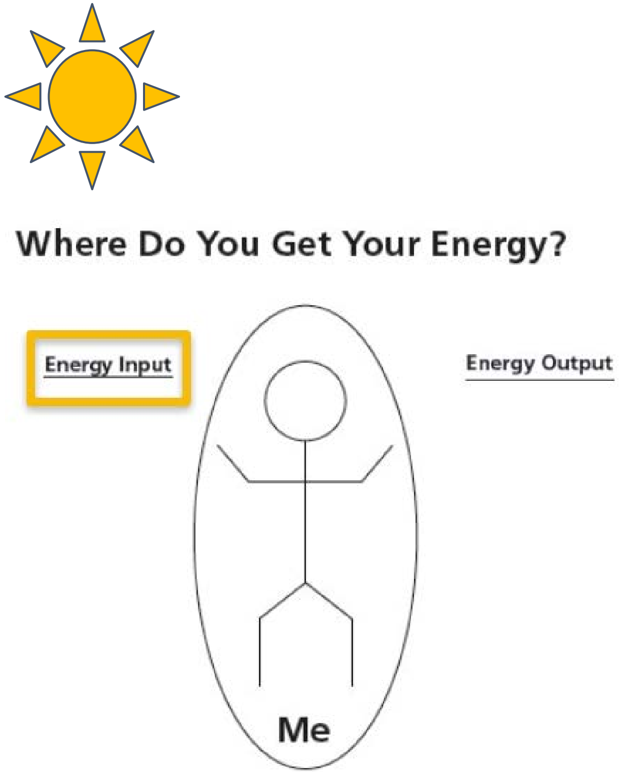
Energy Output

A

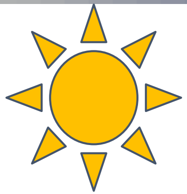
- The Sun transfers its energy to plants. Plants transform that energy into food.
- What do the words "transfer" and "transform" mean?
- Why is the Sun considered a source of energy in this system?
- How would you define "energy transfer"?

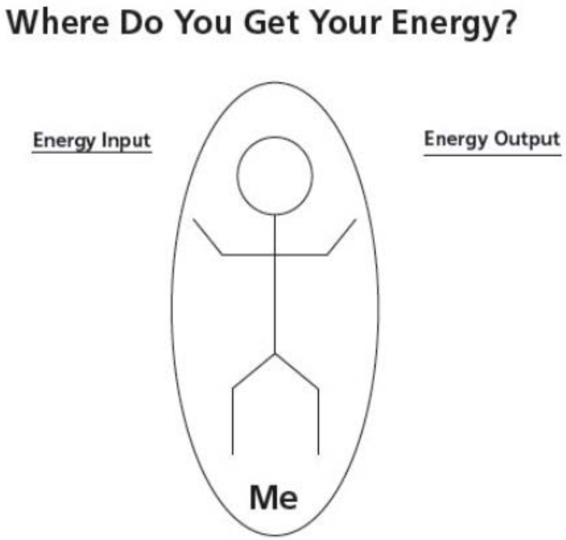


- How would you define “energy transformation”?
- Make a connection between the Sun, plants, animals, and humans. How could we draw arrows on the chart to show energy transfer?
- Where does this chart show energy being transformed?

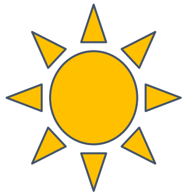


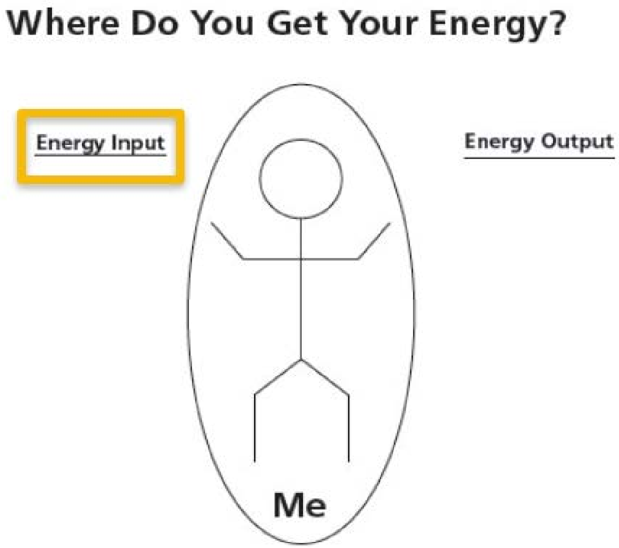
To get ready for a game, a volleyball player eats a chicken sandwich. The meat for the sandwich came from a chicken that was fed a corn-based diet. Edit your energy chart to show the system of energy for the volleyball player by drawing arrows to show the evidence of energy flow.





- What problems would we encounter if the Sun didn't exist?
- What do you think would happen if seeds were planted in an area without sunlight?
- Could the energy system in your chart exist without the Sun? Why or why not?



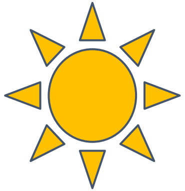


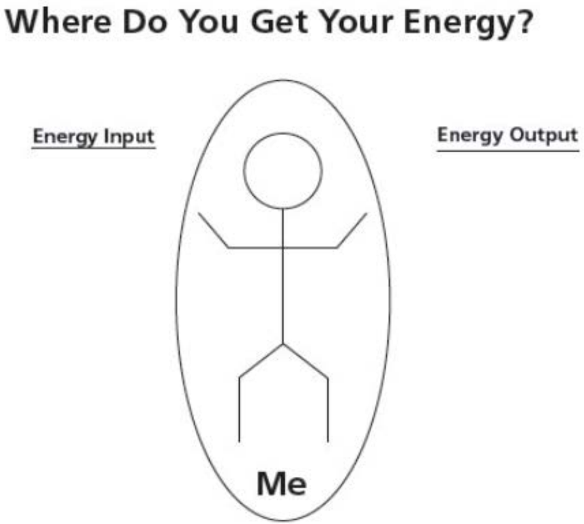
Based on the energy flow chart you created in this investigation, could you say that humans are solar-powered? Why or why not?

Lesson 1, Investigation B

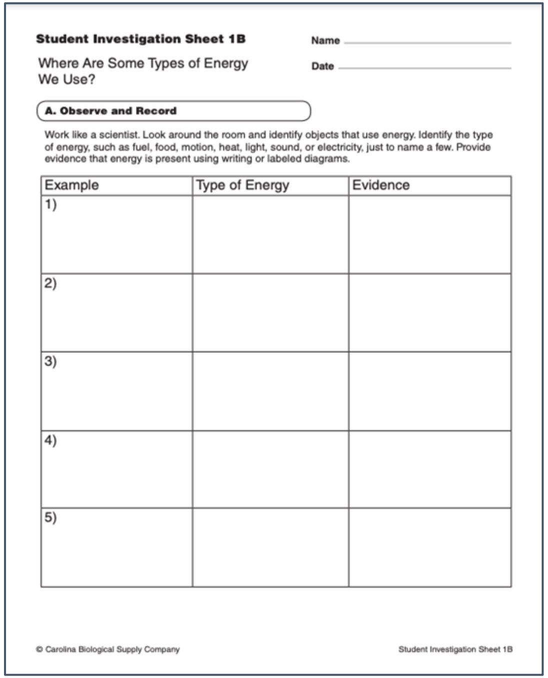
What Are Some Types of Energy We Use?

- Why do we consider the Sun an important source of energy?
- What is an energy system?
- Do all energy systems include the Sun?





- The classroom is full of energy systems that use different kinds of energy.
- Hunt for things that use energy. For each item, fill in one row of the chart in Part A. List the item that uses energy, the type of energy displayed, and the evidence that energy is present.



Student Investigation Sheet 1B Name

Where Are Some Types of Energy We Use? Date

A. Observe and Record

Work like a scientist. Look around the room and identify objects that use energy. Identify the type of energy, such as fuel, food, motion, heat, light, sound, or electricity, just to name a few. Provide evidence that energy is present using writing or labeled diagrams.

Example	Type of Energy	Evidence
1)		
2)		
3)		
4)		
5)		

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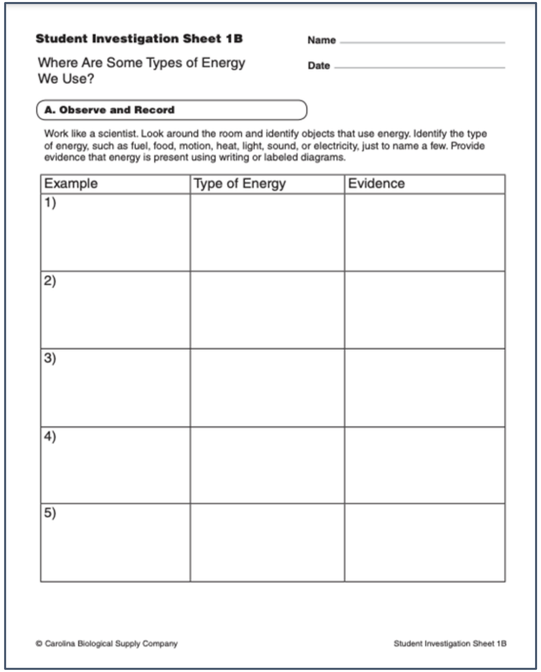
Student Investigation Sheet 1B

- Choose one example of energy that you identified. What evidence would suggest that the energy system was not working?
- What might cause the energy flowing through the system to stop?
- Imagine a lamp does not emit light when the switch is turned on. You replace the bulb, but it still does not turn on. What might you need to consider?



Student Investigation Sheet 1B

Name

Date

Where Are Some Types of Energy We Use?

A. Observe and Record

Work like a scientist. Look around the room and identify objects that use energy. Identify the type of energy, such as fuel, food, motion, heat, light, sound, or electricity, just to name a few. Provide evidence that energy is present using writing or labeled diagrams.

Example	Type of Energy	Evidence
1)		
2)		
3)		
4)		
5)		

Imagine you are riding a bike up a hill on a sunny day. You take a break at the top of the hill to drink water, and then you ride down the hill. When did you use the least energy? When did you use the most energy? When did your energy change from one kind to another?

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. Why is this?

What do we know now?

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:** Energy in a Table Tennis Ball
- **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 Table Tennis Ball?**
Students drop table tennis 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 and motion energy.
- Recognize that when objects collide, energy is transferred between them.

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.

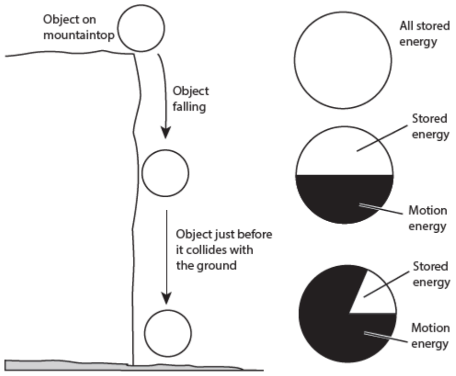


Figure 2.1: Pie charts showing energy transformation as an object falls from a height.

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.)*

Investigation B

HOW CAN I CHANGE THE ENERGY IN A TABLE TENNIS BALL?

MATERIALS

- **Student**

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

- **Team of two students**

1 Table tennis ball

- **Teacher**

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

*These materials are needed but not supplied.

1. Hold up a table tennis ball. Challenge students to describe the energy in the ball. Ask:

- When does a table tennis ball have stored energy? *(The table tennis 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 table tennis ball? *(Drop the table tennis ball.)*
- What evidence can we use to identify that energy is being transformed? *(The table tennis 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 Table Tennis 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 table tennis ball to each pair.

5. Ask pairs to make a prediction about how the energy in the table tennis 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:** Energy in a Table Tennis Ball

Digital Tip

Use the Energy in a Table Tennis Ball simulation to support the opening discussion about the energy in a table tennis 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.

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 table tennis balls. Ask:

- How did energy transform? *(When the table tennis 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 table tennis ball was dropped onto another object, like a pencil or another ball. Ask:

- Predict what would happen to the energy in the table tennis ball if it hit another object. *(Answers will vary. Students should recognize that an energy transfer would occur, or that the table tennis 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.)*

Energy Transfers and Transformations

LESSON ESSENTIALS

Performance Expectations
- **4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

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
- Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

Literacy Components
- *Energy Works* Literacy Reader, pgs. pgs. 3–5, 8–9
- **Literacy Article 3A:** What Do a Wind-Up Toy, a Cell Phone, and a Doorbell Have in Common?

Digital Components‡
- **Interactive Whiteboard:** Where Do You Get Your Energy? (from Lesson 1)
- **Interactive Whiteboard:** Energy Transfers and Transformations
- **Interactive Whiteboard:** Bulbs and Batteries, Mystery Box, and Solar Cells
- **Simulation:** Building a Circuit
- **Simulation:** Solar Cells

‡ 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 3: 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?

Anticipated Questions:
- What causes my skin to tan?
- Why do I feel hotter when I'm in the Sun?
- Why do some plants grow larger in the sunlight than in the shade?

LESSON OVERVIEW

In the previous lessons, students explored energy by defining different types of energy. By examining falling and colliding objects, students explored when energy was being transformed and transferred. In this lesson, students continue to grapple with concepts related to energy transfer, and they explore this concept further by using circuits. Students will explore how energy flows in a system and explain the different types of energy that can be observed. In the next lesson, wave energy will be introduced. Students will learn how the patterns of waves define their energy, and they will elaborate on how such patterns can be used to transfer information.

INVESTIGATION OVERVIEW

Investigation A: How Is the Sun's Energy Transferred?
Students measure and compare the temperature of soil in the sunlight and in the shade.
- **Teacher Preparation:** 10 minutes
- **Lesson:** 30 minutes

Investigation B: How Do You Build an Electric Circuit?
Students practice building electric circuits and identify energy transfers and transformations.
- **Teacher Preparation:** 20 minutes
- **Lesson:** 30–45 minutes

Investigation C: How Can We Use Circuits to Investigate Energy?
Students manipulate circuits and identify the effects on the energy within the system.
- **Teacher Preparation:** 10 minutes
- **Lesson:** 90 minutes

Investigation D: What Have You Learned About Energy?
In a classroom discussion, students share their findings from Investigation C.
- **Teacher Preparation:** 5 minutes
- **Lesson:** 30 minutes

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

Science and Engineering Practice
- Constructing Explanations and Designing Solutions

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

5Es
- Explore
- Elaborate

Literacy Components
- *Energy Works* Literacy Reader, pg. 3
- **Literacy Article 3A:** What Do a Wind-Up Toy, a Cell Phone, and a Doorbell Have in Common?

Digital Component
- **Interactive Whiteboard:** Where Do You Get Your Energy?

Literacy Tip

To support students as they learn about energy transfer, ask students to read Literacy Article 3A: What Do a Wind-Up Toy, a Cell Phone, and a Doorbell Have in Common?

Identify Phenomena

If you're able to take your class outside, encourage students to make observations about how the Sun feels on their skin. Ask if they notice a difference between direct sunlight and shade.

Investigation A

HOW IS THE SUN'S ENERGY TRANSFERRED?

MATERIALS

- **Student**

1 Science notebook*
1 Student Investigation Sheet 3A: *How Is the Sun's Energy Transferred?*

- **Team of two students**

2 Plastic cups, 9 oz
2 Thermometers
Soil

- **Class**

Class Chart from Lesson 1: "Where Do You Get Your Energy?"

- **Teacher**

1 Student Investigation Sheet 3A: *How Is the Sun's Energy Transferred?* (Teacher's Version)

*These materials are needed but not supplied.

1. Refer to the "Where Do You Get Your Energy?" chart from Lesson 1 to briefly review the Sun as an energy source. Ask:
- Describe the transfer and transformation of energy between the Sun and living things. *(Plants take in energy from the Sun to make chemical energy. Animals eat plants or other animals and use the chemical energy they obtain by doing so to live and grow.)*
- What evidence can you provide that plants take in the Sun's energy? *(Plants grow and reproduce.)*
- What evidence can you provide that animals obtain chemical energy from plants and other animals? *(Animals use the energy to live, grow, and reproduce. Animals tend to have more energy for activities if they have eaten.)*
- What types of energy does the Sun give off? *(Light energy and thermal energy. Students may also mention solar or radiant energy.)*

2. Direct students to think about the Sun as a source of heat. Ask them to brainstorm with a partner any evidence that the Sun gives off thermal energy, or heat, and to record this evidence in their science notebooks. After some time, invite students to share their examples.

3. Distribute a copy of Student Investigation Sheet 3A: *How Is the Sun's Energy Transferred?* to each student. Explain that students will work in pairs to examine the Sun's energy transfer by focusing on thermal energy. Ask students to record a prediction in Part A of the investigation sheet.

4. Preview the directions in Parts B and C as a class. Allow students to gather their materials, set up, and make and record observations as directed in Part C of Student Investigation Sheet 3A.

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

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

5Es
- Explore
- Explain

Literacy Component
- *Energy Works* Literacy Reader, pgs. 5, 8–9

Digital Component
- **Simulation:** Building a Circuit

Digital Tip

To support discussion of circuits, use the Building a Circuit simulation to have students identify the components of a circuit and how to organize them.

Investigation B

HOW DO YOU BUILD AN ELECTRIC CIRCUIT?

MATERIALS

Student
- 1 Science notebook*

Team of two students
- 1 Battery
- 1 Battery holder
- 1 Bulb holder
- 1 Mini lightbulb
- 2 Pieces of wire, 30 cm long, with both ends stripped

Teacher
- 1 Pair of wire strippers
- 1 Roll of insulated electrical wire

*These materials are needed but not supplied.

1. Divide students into pairs. Explain that several of the investigations in this lesson will use circuits to explore energy systems. Ask:

- Describe a circuit. How can a circuit be used to explore energy systems? *(A circuit is a system that transfers energy using an energy source to fuel the system.)*
- All energy systems require an energy source. What are some examples of energy sources used in circuits? What types of energy do they use? *(Answers will vary. Examples include batteries or fuel as chemical energy.)*
- Circuits are used in many devices and appliances in your home. Provide examples of devices and appliances that use circuits. What questions do you have about their energy? *(Answers will vary. Examples include cell phones, televisions, speakers, toasters.)*

2. Review the terms "energy transformation" and "energy transfer" with students. Explain that energy is transformed as it changes into different kinds of energy. Energy can also be transferred between objects within a system. Provide time for students to ask questions to help them distinguish between these terms. Encourage students to practice applying these terms as they respond to the following question:

- Think about the energy system that is your body. Beginning with the Sun, identify the energy transformations and transfers that fuel the body. *(The Sun transfers light energy to plants, which absorb it and transform it into chemical energy to make food and grow. The chemical energy from plants is transferred to animals so they can live and grow. When humans eat plants or animals, the chemical energy is transferred to the human, and it can be stored as chemical energy or transformed into mechanical or thermal energy to power their activities.)*

Teaching Tip

Students may struggle with this terminology; using correct terminology when speaking to students and asking students to use the terms in their explanations will help to dispel misconceptions. You might offer another example in which the terms are correctly applied: Energy is stored in a circuit if the circuit is open. If there is a battery, the energy is stored as chemical energy. When the circuit is closed, the stored energy is transformed into motion energy, and many energy transfers occur. The chemical energy from the battery is transformed into electrical energy in the wires and can be transferred to a bulb or a motor.

Investigation C

HOW CAN WE USE CIRCUITS TO INVESTIGATE ENERGY?

MATERIALS

Student
1 Science notebook*
1 Student Investigation Sheet 3C.1: *How Can We Investigate Energy with Bulbs and Batteries?*
1 Student Investigation Sheet 3C.2: *How Can We Investigate Energy with a Mystery Box?*
1 Student Investigation Sheet 3C.3: *How Can We Investigate Energy with Solar Cells?*

Team of two students
For Bulbs and Batteries
3 Batteries
3 Battery holders
1 Bulb holder
1 Mini lightbulb
2 Pieces of wire, 8 cm long, with both ends stripped
2 Pieces of wire, 30 cm long, with both ends stripped

For Mystery Box
1 Battery
1 Battery holder
1 Electrical mystery box (buzzer)
2 Pieces of wire, 30 cm long, with both ends stripped

For Solar Cells
1 Motor with attached wires
1 Solar panel with attached wires

Teacher
1 Student Investigation Sheet 3C.1: *How Can We Investigate Energy with Bulbs and Batteries?* (Teacher's Version)
1 Student Investigation Sheet 3C.2: *How Can We Investigate Energy with a Mystery Box?* (Teacher's Version)
1 Student Investigation Sheet 3C.3: *How Can We Investigate Energy with Solar Cells?* (Teacher's Version)
1 Pair of wire strippers
1 Roll of insulated electrical wire

*These materials are needed but not supplied.

Disciplinary Core Ideas
- **PS3.A:** Definitions of Energy
- **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

Literacy Component
- *Energy Works* Literacy Reader, pgs. 4–5, 8–9

Digital Components
- **Interactive Whiteboard:** Energy Transfers and Transformations
- **Simulation:** Solar Cells

1. Review energy with students. Ask:

- How do circuits provide evidence of energy transformation? *(When circuits are closed, they transform stored energy into motion energy. Depending on what the circuit is powering, there may be evidence of additional energy transformations, including light, sound, or motion.)*
- How do circuits provide evidence of energy transfer? *(Closed circuits allow energy to flow throughout a system. Evidence can be displayed with an effect such as a bulb emitting light.)*

2. Explain that students will work in pairs to build three circuits to investigate energy systems. Let students know that they will have one class session to conduct each investigation.

3. Distribute Student Investigation Sheets 3C.1, 3C.2, and 3C.3 to each student. Briefly describe each part of the investigation and the materials that will be used. Use the following to review the concepts associated with this investigation:

a. Bulbs and Batteries

- Students will predict how the energy of the system changes as more batteries are added. Students will explain how the energy input in a system affects the total energy in the system.

Teaching Tip

Caution students to handle the solar panels gently. The wires on the panels can easily become dislodged.

Teaching Tip

Motors work when their parts spin, thus transforming or transferring energy. However, some motors must be primed, or prepared, to start their parts spinning. If the motors do not start spinning once connected to the solar cells, you may need to prime them by spinning the shaft with your fingers.

Digital Tip

If students appear to struggle with the solar cells, supplement with the Solar Cells simulation.

Identify Phenomena

Relate this investigation to phenomena by comparing electric and solar-powered cars. You may wish to provide a video or article for students and ask them to compare the energy transformations that occur to make the car run. To challenge students, ask them to describe the pros and cons of each type of car.

b. Mystery Box

- Students will practice building a circuit to discover the function of a "mystery box." They must identify how energy is transformed and transferred.

c. Solar Cells

- Students will predict how solar cells work and compare them to batteries. Students must explain how solar panels provide energy in a circuit and are able to transfer and transform energy so a motor can run.

4. Allow time for students to make a prediction in Part A of their investigation sheets.

5. Direct students to Part B of their investigation sheets and review how to identify variables and controls for an experiment. Refer to Investigation B of this lesson as an example. Explain that:

- The independent variable is something that changes. *(For example, whether the circuit was open or closed.)*
- The dependent variable is affected by the thing that changes. *(For example, whether the light bulb emitted light energy.)*
- The dependent variable DEPENDS on the independent variable. *(For example, the light bulb will emit light only if the circuit is closed.)*
- A control is a factor that does not change. *(The number of components in the system did not change.)*

6. Assign each pair of students to begin at one of the three investigations. Before students obtain their materials, explain how to dismantle their equipment and return all their materials for the next class session. Remind students not to share the results of their investigations with other pairs. Remind students that they will have the rest of the class session to complete their first investigation. As they work, circulate among pairs and offer help as needed. Students should complete every part of the student sheet for each investigation.

7. In the next two class sessions, assign each pair to another of the three investigations, allow them to collect their materials, and continue to offer support and encouragement as pairs work to complete all three investigations. Remind students not to share the results of their investigations with other pairs.

Tell Me More!

Design and draw a labeled diagram of a circuit that uses both solar cells and batteries to power a lightbulb. Do you think this setup is similar to one that uses multiple batteries? Explain your answer.

LESSON **4**

Energy Moves in Waves

LESSON ESSENTIALS

Performance Expectations
- **4-PS3-3:** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
- **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.

Disciplinary Core Ideas
- **PS3.C:** Relationship between Energy and Forces
- **PS4.A:** Wave Properties
- **PS4.C:** Information Technologies and Instrumentation

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

Crosscutting Concept
- Patterns

Literacy Component
- **Literacy Article 4C:** Should You Go Surfing During a Tsunami?

Digital Components‡
- **Interactive Whiteboard:** Let's Find Out About Water Waves
- **Simulation:** Wind Waves
- **Simulation:** Marble Waves
- **Simulation:** Morse Code Demo

‡ 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 4: 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?

Anticipated Questions:
- What does a heliograph look like?
- Why do soldiers use heliographs instead of radios?
- How can flashing light represent letters and numbers?

LESSON OVERVIEW

In the previous lessons, students investigated different forms of energy by observing energy transfers and transformations. At this point in the unit, students understand that energy flows within a system and that energy is never gained or lost. This lesson focuses on energy in the form of waves. Using previous knowledge and classroom observations, students describe the appearance and movement of water waves. They apply their observations to label a wave diagram, and they learn that other forms of energy, such as light, also move in waves. Using concepts from previous lessons, students describe wave energy transfers and recognize patterns. Using Morse code as an example, students use similar patterns to transfer information. In the next lessons, students will learn about wave energy as a type of alternative energy by focusing on water and solar energy. They will apply knowledge of energy systems to explain how alternative energy is renewable and will elaborate on the benefits of these forms of energy.

OBJECTIVES

- 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.

VOCABULARY

- Amplitude
- Frequency
- Wave
- Wavelength

LESSON **5**

Recycling Energy

LESSON ESSENTIALS

Performance Expectations
- **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-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-ETS1-3:** 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
- **ESS3.A:** Natural Resources
- **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

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

Literacy Components
- *Energy Works* Literacy Reader, pgs. 10–14
- **Literacy Article 5A:** Wacky Alternative Energy

Digital Components‡
- **Interactive Whiteboard:** Alternative Energy
- **Simulation:** Wind Turbine
- **Simulation:** Waterwheel

‡ 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 5: 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?

Anticipated Questions:
- Is it expensive to have solar panels?
- Why don't all machines use solar panels?
- Can a solar panel work without sunlight?
- What kinds of machines use solar power?

LESSON OVERVIEW

In the previous lessons, students have examined different types of energy, manipulated them in a system, and observed how they can be transferred by using models and analyzing data. Lesson 5 introduces alternative energy sources as potential replacements for fossil fuels and provides engineering opportunities for students to construct their own wind turbines and waterwheels. The concepts in this lesson have strong correlations with current events, providing many opportunities for inquiry and discussion. Students should be able to apply their knowledge from this unit to explain how renewable energy can be harnessed, transferred, transformed, and reused to power common devices. In the next lesson, students will use what they have learned in previous lessons to design their own energy experiments that demonstrate the primary concepts from the unit.

INVESTIGATION OVERVIEW

Investigation A: What Are Types of Alternative of Energy?
As a class, students create a chart to explain the different types of alternative energy and how they are used.
- **Teacher Preparation:** 15 minutes
- **Lesson:** 30 minutes

Investigation B: How Does a Wind Turbine Generate Energy?
Students construct a wind turbine to explore the concept of wind energy.
- **Teacher Preparation:** 15 minutes
- **Lesson:** 30 minutes

Investigation C: What Can I Build to Demonstrate Water Energy?
Students develop a model waterwheel and explore how the energy in the system can vary.
- **Teacher Preparation:** 20 minutes
- **Lesson:** 30 minutes

My Energy Experiment

LESSON ESSENTIALS

Performance Expectations
- **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-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Disciplinary Core Ideas
- **PS3.A:** Definitions of Energy
- **PS3.B:** Conservation of Energy and Energy Transfer
- **PS3.D:** Energy in Chemical Processes and Everyday Life
- **ETS1.B:** Developing Possible Solutions
- **ETS1.C:** Optimizing the Design Solution

Science and Engineering Practices
- Developing and Using Models
- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts
- Cause and Effect
- Energy and Matter

Digital Component‡
- **Interactive Whiteboard:** My Energy Experiment

‡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 to provide support for the unit's anchoring phenomenon.

Investigative Phenomenon for Lesson 6: 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?

Anticipated Questions:
- How are energy-efficient devices different from other devices?
- How can renewable energy be used to power energy-efficient devices?
- What are some other examples of energy-efficient devices?

LESSON OVERVIEW

Throughout the unit, students have used hands-on, inquiry-based science explorations to engage with concepts related to energy, explain concepts using evidence and reasoning, and elaborate upon ideas. By way of these experiences, students should recognize that energy comes in many types that can be transferred or transferred. In this final lesson, students will work in groups to design an experiment that shows the many types of energy, that energy can be transformed from one type to another, and that energy does work or creates change. After testing, students will demonstrate their experiment and communicate their findings to the class in a presentation. As a review and assessment strategy, students compare their knowledge from the beginning of the unit to what they know now. This practice encourages students to evaluate their own progress and acknowledge what they have learned about energy. By the end of the unit, students should be able to provide an in-depth explanation of how energy impacts their daily lives in a multitude of ways.

OBJECTIVES

- 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.

INVESTIGATION OVERVIEW

Investigation A: How Can I Design an Experiment About Energy?
In teams, students develop a question about energy, make a prediction, and design an experiment to test their question.
- **Teacher Preparation:** 10 minutes
- **Lesson:** 30–60 minutes

Investigation B: Does My Experiment Support My Prediction?
Students conduct their experiment to determine if their prediction was supported and design a presentation about their findings.
- **Teacher Preparation:** Time will vary
- **Lesson:** 60 minutes or more

Investigation C: How Can I Communicate What I Have Learned About Energy?
Students present their energy experiments and evaluate what they have learned throughout the unit.
- **Teacher Preparation:** 10 minutes (will increase if you invite guests)
- **Lesson:** 60 minutes or more

VOCABULARY

- All vocabulary from previous lessons.

MATERIALS

Student
- 1 Science notebook*
- 1 Student Investigation Sheet 6A: *Can I Design an Experiment to Demonstrate Energy?*
- 1 Student Investigation Sheet 1B: *What Are Some Types of Energy We Use?* (completed in Lesson 1)
- 1 Student Investigation Sheet 1B: *What Are Some Types of Energy We Use?* (blank)
- 1 Summative Assessment

Class
- Additional materials for students to use in their experiments* (optional)
- All materials from previous activities
- Class chart "Where Do You Get Your Energy?" from Lesson 1*

Teacher
- 8 Teacher Sheet 6C: *My Energy Experiment Rubric*
- 1 Student Investigation Sheet 1B: *What Are Some Types of Energy We Use?* (Teacher's Version)
- 1 Summative Assessment Answer Key
- Chart paper or whiteboard*
- Markers*

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 one copy of Student Investigation Sheet 6A: *Can I Design an Experiment to Demonstrate Energy?* for each student.

2. Using a whiteboard or chart paper, create two charts titled "Planning an Experiment" and "Questions to Investigate." Hang them next to each other. Alternatively, you may use Interactive Whiteboard: My Energy Experiment.

3. Gather materials from previous investigations that students may use in their energy experiments. Suggested materials include batteries, battery holders, lightbulbs, bulb holders, solar cells, wires, wind turbines, motors, waterwheels, and marbles. Develop a method for students to access these materials.

4. Students may design an experiment that requires additional materials. Decide if you will provide these materials or ask students to bring them in.

5. It is recommended that students perform this investigation in teams of two; the kit includes 35 batteries and 35 battery holders, which is enough for each pair to have two of each, with a few available for the class to share. However, if time is a concern, you may organize students into teams of four.

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Evaluations: Share Your Thoughts

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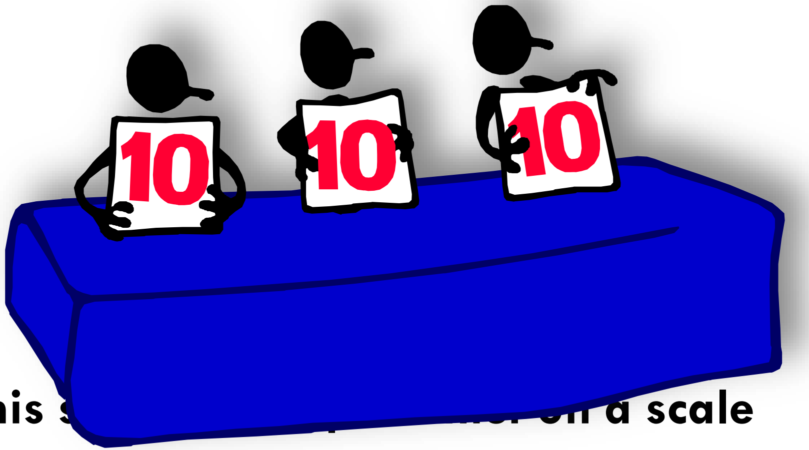

- Please evaluate this s … on a scale from 0 to 10 (10 = best).