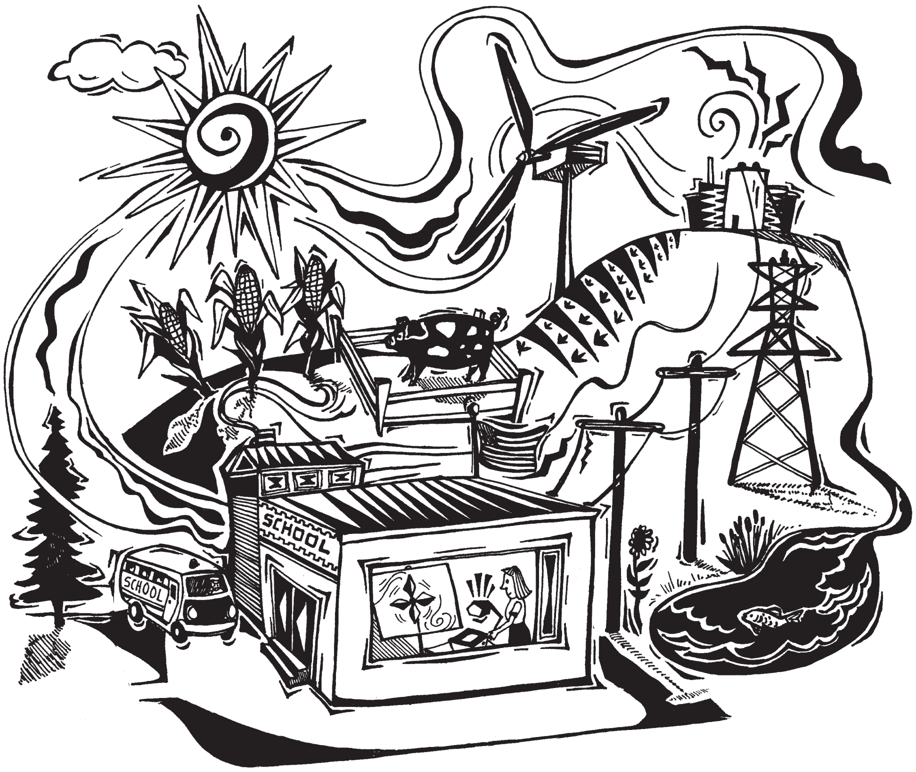
Know the Flow of Energy in Your School

A Supplement to the KEEP *Energy Education Activity Guide*

For teachers of kindergarten through fourth-grade students



Wisconsin K-12 Energy Education Program (KEEP)
College of Natural Resources
University of Wisconsin-Stevens Point

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Know the Flow of Energy in Your School is a supplement to the KEEP *Energy Education Activity Guide.* The supplement can be used as a stand-alone unit, but will be enriched if used in conjunction with the KEEP *Energy Education Activity Guide*. References to the guide and suggested complementary activities are provided throughout this supplement. If you are interested in participating in a KEEP professional development opportunity, please contact the KEEP office at 715.346.4770 or Email keep@uwsp.edu for more information.

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Development of KEEP Elementary Education Supplement

At the time of development, more than 400 elementary teachers had participated in KEEP classes. They reported that their students greatly enjoyed participating in KEEP activities and learning important energy concepts. Teachers of young students especially appreciate KEEP activities because energy is an abstract subject and the hands-on lessons meet the learning needs of their students who think at the concrete operational level. Therefore, elementary teachers greatly desire and have requested more activities to help make energy relevant and interesting to their students' lives. The *Know the Flow of Energy in Your School* supplement is designed to help the teacher use the school as an educational tool by introducing kindergarten through fourth grade students to energy in a way that connects it directly to their lives. It's designed to make learning fun through hands-on, exploratory activities.

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What is the Wisconsin K–12 Energy Education Program?

The Wisconsin K-12 Energy Education Program (KEEP) was created to help promote energy education in Wisconsin. In 1993, the Wisconsin Center for Environmental Education (WCEE) proposed that a comprehensive guide to K–12 energy education in Wisconsin be developed. In 1995, the Energy Center of Wisconsin (ECW), a nonprofit energy efficiency research organization based in Madison, agreed to fund the project. The Wisconsin Environmental Education Board and the University of Wisconsin-Stevens Point also provided support.

In 2000, the ECW (now Seventhwave), worked with KEEP staff to ensure long-term financial support through Focus on Energy, Wisconsin's Public Benefits Program, a public-private partnership offering energy information and services to energy utility customers throughout Wisconsin. The partnership with Focus on Energy ended in May 2012. Recognizing KEEP's value, Wisconsin's six major utilities have continued their funding for KEEP on an annual basis.

For more than twenty years, the Wisconsin K–12 Energy Education Program (KEEP) has been working with teachers, administrators, and energy resource managers to increase and improve energy education in Wisconsin schools. The KEEP curriculum and other services and support materials provide Wisconsin students of every grade level the opportunity to receive a logically sequenced, comprehensive education about energy.

Vision

Communities making informed energy choices now and for a sustainable future.

Mission Statement

The mission of KEEP is to initiate and facilitate the development, dissemination, implementation, and evaluation of energy education programs within Wisconsin schools.

Goal

The goal of KEEP is to leverage teacher education to improve and increase energy literacy in Wisconsin's K-12 communities as a means of contributing to statewide energy savings.

KEEP Accomplishments

A Conceptual Guide to K–12 Energy Education in Wisconsin: Identifies important energy concepts that students should know and understand.

KEEP *Energy Education Activity Guide* and Supplemental Guides: Contain hands-on, interdisciplinary lessons that are aligned with Wisconsin's academic standards, Next Generation Science Standards and Common Core State Standards and make energy relevant to students' lives.

Professional Development Courses and Workshops for K–12 educators: Provide educators with hands-on experience teaching lessons from the KEEP *Energy Education Activity Guide* and supplements and introduce them to additional energy-related teaching resources. These offerings increase teachers' energy literacy and increase the likelihood that they will implement KEEP materials in their classrooms.

Web-based Energy Literacy Courses: Energy education via the Internet; the content of two interactive courses is available at no charge to teachers year-round via the KEEP website.

Renewable Energy Education: Activities, support materials, and inservice courses provide teachers with background information about renewable energy they can share with students.

Statewide Network of Energy Educators: KEEP provides continued support for teachers via online newsletters, the website, social media, and conferences, and through the lending of hands-on resources, tools, and take-home activities for students as they develop 21st century skills.

Partnerships in Energy Education: Working collaboratively with Focus on Energy, utilities, and various energy resource professionals, KEEP promotes energy education and efficiency in homes, schools, and communities.

Over 6,700 teachers throughout the state have participated in KEEP professional development offerings. These teachers are in turn increasing the quality and quantity of energy education for thousands of Wisconsin K–12 students. These teachers report that they now have the knowledge and experience to teach about energy, and that their classroom teaching includes more activities and lessons about energy.

A Rationale for Energy Education

Energy education can help students of today handle many of the energy resource issues and opportunities our nation faces. We have challenging energy decisions ahead of us, and the solutions will include a mix of energy efficiency measures, new technologies, and renewable resources. These decisions will need to be made by educated individuals who have a solid understanding of energy basics, including the pros and cons of both renewable and nonrenewable resources.

What do people know and think about energy? Some will describe how they use energy in their lives and at their workplaces. Many will mention the cost while others will express concern about environmental impacts. While acknowledging these issues, nearly all people will agree that energy is necessary for maintaining their health, their well-being, their lifestyles, and their economy. Many will even say that they often take energy for granted.

Energy is more than an individual economic, environmental, or sociopolitical issue, or passing concern. It is the agent of change for all processes on Earth and throughout the universe. Every interaction among living and nonliving things is accompanied by the transfer and conversion of energy. Energy is the underlying “currency” that is necessary for everything humans do with each other—whether in the workplace or in their personal lives—and with the natural environment that supports them. Understanding energy in this way enables people to see how issues are interconnected and how a solution to one issue may even lead to the solution of another. For instance, the person who buys a fuel-efficient car saves money on gasoline, reduces air emissions, and decreases our nation’s reliance on imported oil/fossil fuels.

Many people believe more needs to be done if energy education is to be widely and consistently instituted throughout Wisconsin in a manner that effectively promotes lifelong learning and links students to the world around them. This program utilizes and encourages school-to-career skills and the use of a rich set of community resources, including professionals representing Wisconsin’s investor-owned, municipal, and cooperative utilities as well as businesses, environmental organizations, and institutions of higher education. KEEP, through its curriculum, provides a path for students in Wisconsin schools to receive a logically sequenced, comprehensive energy education.

Table of Contents

K-4 Supplement Overview

Evidence of energy is all around us. Heat, light, sound, wind, and movement are examples of energy that can be observed in the classroom, school building, schoolyard, home, and community. Energy plays an essential role in the lives of people, including schoolchildren. Whether children are playing, studying, walking to school, or eating lunch, energy is involved. It is important that students have a fundamental knowledge of the nature of energy and appreciate how their lifestyles depend on energy. Increasing students' energy literacy is more important than ever in the twenty-first century as we face energy-related environmental, social, and political challenges as a global society.

Young learners often have difficulty understanding what energy is because it is intangible and takes many forms. The *Know the Flow of Energy in Your School* supplement uses the school as an educational tool to connect energy directly to the lives of students. It also helps kindergarten through fourth grade teachers introduce this challenging concept to students. Connecting energy to everyday situations facilitates the learning process and makes the lessons pertinent to students. Energy from the Sun, Energy from the Wind, Energy from Food, and Energy from Electricity engage students in hands-on activities where they illustrate evidence of energy and its flow in their immediate surroundings.

Know the Flow of Energy in Your School can be completed as a comprehensive unit, or activities within the unit can be conducted separately. If you choose to complete the entire unit, you might want to conclude with "Energy Use in an Ecosystem" from Theme 1: We Need Energy in the KEEP *Energy Education Activity Guide*. This theme is an advanced lesson that can be used as an assessment tool to gauge students' understanding of the overall unit.

Objectives

Students will be able to illustrate how:

- sunshine flows through their school
- the wind flows through their school
- energy in food flows through their school
- electricity flows through their school

Making Connections: A Comprehensive Assessment

Wouldn't it be nice to have an assessment tool that monitors student progress within the activities and ties each activity together at the end of the unit? ***Know the Flow of Energy in Your School*** provides teachers with two tools in the form of an ***Energy Learning Log*** and ***Energy Flow Mural***. Look for references to these tools throughout the supplement.

Energy Learning Log

An ***Energy Learning Log*** is beneficial because it helps teachers organize and plan a project and monitor student progress. It also aids the learner because it can be used as a reflective tool. It is recommended that an ***Energy Learning Log*** portfolio be used throughout this unit as a formative and summative assessment tool. The ***Energy Learning Log*** will be used to track energy flow throughout the school by documenting patterns in solar energy, wind movement, food chains, and electrical flow. It will also help to re-create student findings for a comprehensive mural activity (see instructions below). An ***Energy Learning Log*** can be of any format, such as an accordion folder, a spiral or loose-leaf notebook, etc. Invite the students to personalize the outside of their logs with drawn or cut-and-paste illustrations relating to energy.

Energy Learning Logs as a Vehicle for Pre-assessment
Prior to any instruction on energy, invite students to write about energy for 15 minutes or so. They should write down anything that comes to mind, keeping their pen or pencil to the paper at all times. If their mind is blank, suggest they write the word energy over and over again until they think of something related to energy, or they can write about why they can't think of anything related to energy. After students are done writing, ask them to summarize what they wrote by writing down three statements that they think they know about energy, and three questions that they have about energy. These questions can be discussed as a class, shared with the teacher on an individual basis, or kept private. At the end of the energy unit, have students revisit these questions and statements and answer or rewrite them as needed.

Energy Learning Logs as a Reflective Tool and to Monitor Progress
Use the Energy Learning Log to link different energy concepts students have learned. When students are learning new

concepts, encourage them to refer to previous information. Allow time at the end of each energy education activity for students to summarize and interpret what they experienced. They should view these writing opportunities as a means to express their personal insights. They are striving to make the energy activity meaningful and to apply it to their own lives. By relating what they have observed in their own words, students will discover gaps that need to be filled, make connections among existing thoughts, and raise questions that require further exploration. Students may wish to use parts of the log as a diary. They can record their personal reflections, wishes, and frustrations in a special section of the log, in code, or in a separate journal. In some cases, this section will be designated as writing not to be viewed by the teacher.

Energy Learning Logs to Report and Evaluate Results
An Energy Learning Log can be used to document the results of a project or activity. Actual samples of student work can be part of the log. Samples include artwork, videos, poetry, draft writings, calculations, and test results. One strategy involves having students use the log to show what they think is their best work. Reflective questions should accompany this presentation. For example, students can be asked to explain why they think this is their best work, what they did to make the project successful, what they would do differently, and how this applies to their overall development as a current and future energy consumer.

Adapted from The Watercourse and Western Regional Environmental Education Council (WREEC).“Water Log” pp. 19-21 in Project WET. Bozeman, Mont.: The Watercourse and Western Regional Environmental Education Council (WREEC), 1995. Used with permission. All rights reserved.

Energy Flow Mural

As a summative assessment activity, have students create a mural of the flow of energy through the schoolyard and classroom using the data they collect in their ***Energy Learning Logs***. The mural can depict energy flow around the school-yard and classroom through illustrations of sunny and shaded areas, wind patterns, food chains, and electrical flow.

This comprehensive unit activity acts as a review and ties the unit concepts together. Teachers can also use the mural as a formative assessment tool by having the students create the mural in layers as they progress through the various unit activities.

Know the Flow of Energy in Your Home and Community

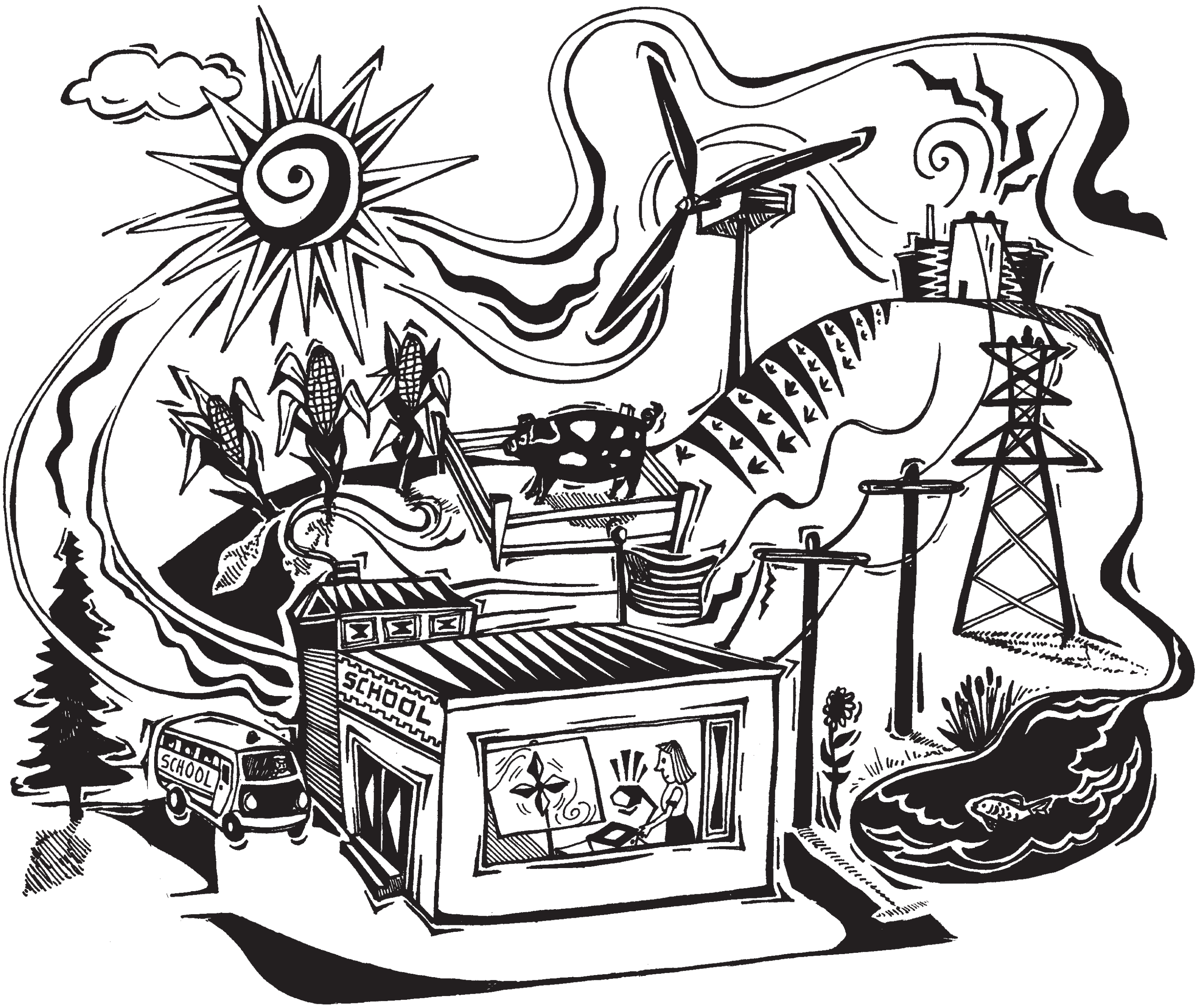
Teachers can extend student understanding of energy flow from the school to the home and community by encouraging students to involve their parents in many of the activities in this supplement. Through these activities, students and their families can identify how energy from the sun, wind, food, and electricity is transferred to, through, and from their homes. For example, if students work with their parents mapping wind (or drafts) in their home and examining electricity use, the family can learn to appreciate the role of energy in their lives and can use this information to make decisions about their energy consumption.

If the class is creating an ***Energy Flow Mural***, students can place their homes and various businesses on the mural. Investigating energy flows in the school, homes, and community and illustrating the flows on the mural is an ideal way for students to examine their lifestyles and the interrelationships among community members. Teachers can invite local utility representatives to speak to the class and use the mural as a visual aid to diagram power lines and discuss safety issues. The mural provides an ideal background for illustrating community transportation and energy-related connections among careers. Community energy connections lead to many other possibilities of study, including career opportunities, community development, and lifestyle analysis. Since energy plays such an integral role in student home life and the community, taking energy lessons beyond the school to the home and community is an ideal strategy to making classroom learning relevant and meaningful to students and their families.

Children’s Literature and Energy

Through storybooks, many aspects of energy come to life for students. Whether children are learning about the sun, wind, food, or electricity, the tales and pictures found in children’s literature will provide examples and illustrations of energy and how it is used.

Sample *Energy Flow Mural*



Unit 1
Energy from the Sun

Activities

Unit Objective

- Students will be able to illustrate how sunshine flows through their school.

Background

The sun is the source of most of Earth's energy. The sun is a star that generates energy through the process of nuclear fusion. The sun's energy reaches Earth in the form of sunshine (radiant energy). Although only a small portion of the sun's radiant energy reaches Earth, it is enough to keep us warm, create our weather, create wind and waves, and enable plants to convert carbon dioxide and water into food (photosynthesis). Without sunshine (light) we would not be able to see objects and colors. Our eyes are adapted to receive light, and our brains translate this information to let us know what we are looking at.

Like all planets in our solar system, Earth orbits around the sun. It takes 365 days for Earth to complete one orbit. Throughout its travels, the planet is spinning on its axis. It takes one day to rotate one time. While it appears that the sun rises and crosses the sky, the sun's apparent path is actually a result of our own planet's rotation.

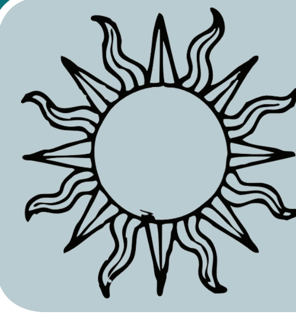
The sun "rises" to our east and "sets" in the west. It appears to be at its highest point in the sky around noon. At night, the sun is shining on the opposite side of the planet while the "night" side is facing away from the sun. When light rays shine on objects they receive the light and can block it from traveling any further. Shadows are essentially blocked light. Opaque objects block light, and transparent items such as clear windows, allow light to pass through them. Other objects are translucent; they are not clear but allow some light to pass through (e.g., a piece of wax paper).

Depending on the direction and location of the light source, a shadow's length and size will vary. In the morning, shadows created by blocked sunlight appear long and point in a western direction. In the evening they are long and point eastward. During midday our shadows appear shorter and point in a northern direction. Shadow length will also vary with the seasons. During the summer, the sun crosses the sky at a higher altitude (shines more directly on Earth's surface) and shadows will be shorter. In winter, the sun is lower in the sky and shadows will be longer.

For more information about the sun, see the "Facts about Solar Energy: Solar Heating" in the KEEP *Energy Education Activity Guide* and the following KEEP activities and Sparks available at keepprogram.org:

- Sun, Wind, Water
- Shoebox Solar Cooker
- Sunvestigations

What the Sun Does for Me



Summary:
Students illustrate ways the sun contributes to their lives.

Grade Level: K-4

Subject Areas: Language Arts, Mathematics, Earth and Physical Science, Environmental Literacy & Sustainability, Art, Family Living and Consumer Education

Setting: Classroom or outdoor work area

Time:
Preparation: 10 minutes
Activity: 50-minute period

Vocabulary: Heat, Light, Solar energy, Sun

Materials:
- Copies of ***What the Sun Does for Me*** activity sheet
- ***Energy Learning Log*** and writing implements: markers, crayons, or poster paint and other art supplies (if you do not use the activity sheet)
- Construction paper and glue

Standards Addressed:
CC ELA: L.K-2.6, L.1.5.B, RI.3.4, SL.K.1.A, SL.K.3-4&6, SL.1.1.B-C, SL.1.4-5, SL.2.1.B-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, W.K.2&8, W.1-4.8, W.3.1.A

CC Math: MP5, 1.MD.3

NGSS: K-PS3-1
SEP: Planning and Carrying Out Investigations
DCI: PS3.B: Conservation of Energy and Energy Transfer
CCC: Cause and Effect

EL&S: Connect: C1.A.e, C1.A.i, C1.B.e, C1.C.e, C1.D.e
Explore: EX2.A.e, EX2.A.i, EX2.B.i, EX2.C.e, EX3.B.e, EX4.A.e, EX4.A.i, EX5.B.e, EX5.B.i

Related KEEP Activities:
In "Sun, Wind, Water" students use art skills to emphasize the role of energy in the water cycle. For more fun sun activities, check out the KEEP Energy Spark "Sunvestigations" at keepprogram.org.

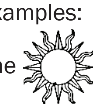
Objective

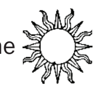
- Students will be able to identify ways that the sun contributes to their lives.

Procedure

1. Ask students to share their thoughts about the sun. Hand out copies of ***What the Sun Does for Me*** activity sheet and have students generate ideas about what jobs they think the sun does. Have students put the activity sheets or pictures in their ***Energy Learning Logs***.

Examples:

The  warms me.

The  helps a  grow.

NOTE: Have preliterate students construct pictures using art supplies.

2. Write or draw students' ideas on the blackboard and have students group them into categories, such as light, heat, wind, and plant growth. Did they think of other ideas during the discussion? Add them to the list.

3. Discuss which category was best represented (light, heat, plant growth, etc.). Why is this? Discuss categories that students may have underrepresented and have them generate new ideas.

4. Have each student choose one or more of the jobs to illustrate through artwork, such as a drawing, painting, 3-D art, or a poem. As the unit proceeds, more jobs can be illustrated through art projects.

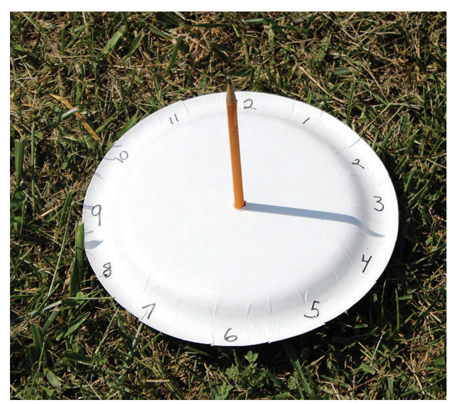
Assessment

- Have students list jobs that the sun does for them ("sun jobs").
- Have students organize the sun jobs under the different categories and insert the information into their ***Energy Learning Logs***.
- Have students incorporate into the ***Energy Flow Mural*** the appropriate sun jobs they generated. Let the students determine if the sun jobs should be grouped or placed in various locations in the schoolyard or classroom on the mural.

Extensions

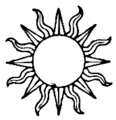
Students can create a mobile that includes the sun and sun jobs to display in the room. Make the sun out of sturdy cardboard. Connect each sun job with string and hang from individual rays.

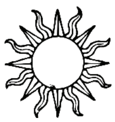
Discuss how people use the sun to tell time or find their way. Have students make a simple sundial. Younger students can make a sundial out of a paper plate, markers, pencils, and a compass. The students write the appropriate numbers in the plate to correspond with a clock. Have them poke a pencil in the center of the plate and secure it with tape so it stands upright (perpendicular to the ground). Take the class outdoors on a sunny day and find north with a compass. Tell them to position their plates to match 12:00 with north. Ask students to note where the pencil shadow falls. The pencil shadow will tell them what time it is throughout the day.

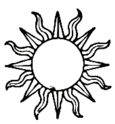


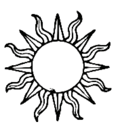
What the Sun Does for Me

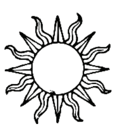
Generate ideas about jobs the sun does for you.

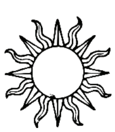
Example: The  helps a  grow.

1. The  ______________________________

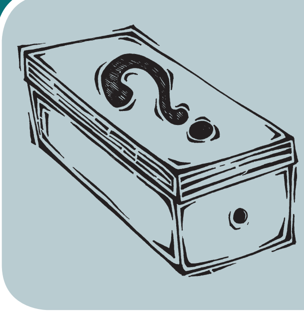
2. The  ______________________________

3. The  ______________________________

4. The  ______________________________

5. The  ______________________________

Let the Sun Shine Through



Summary:
Students construct "Mystery Boxes" to explore qualities of light provided by the sun.

Grade Level: K-4

Subject Areas: Language Arts, Mathematics, Physical Science, Environmental Literacy & Sustainability, Art (if students assemble their own Mystery Boxes)

Setting: Classroom for Mystery Box assemblage; Schoolyard for activity

Time:
Preparation: 30 minutes (plus time to prepare Mystery Boxes)
Activity: 50-minute period

Vocabulary: Energy, Light, Opaque, Solar energy, Sun, Translucent, Transparent

Materials:
- Materials to assemble several Mystery Boxes (see ***Mystery Box Assembly Directions***)
- Flashlight (optional)
- ***Energy Learning Log*** and writing implements

Standards Addressed:
CC ELA: L.K.5.D, L.K-2.6, L.1.5.B, L.2.5.A-B, L.3.5.B, RI.3.4, RI.4.7, SL.K.1.A, SL.K.2-4, SL.K.6, SL.1.1.B-C, SL.1.4, SL.2.1.B-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, W.K.2&8, W.K-4.7

CC Math: MP5

NGSS: 1-PS4-2
SEP: Constructing Explanations and Designing Solutions
DCI: PS4.B: Electromagnetic Radiation
CCC: Cause and Effect

EL&S: Connect: C1.C.e
Explore: EX2.C.e

Related KEEP Activities:
In "Evidence of Energy," students learn by investigating motion, sound, heat and light that they and other objects in the classroom use energy at keepprogram.org.

Objectives

Students will be able to:

- recognize that the sun's energy can be seen as light; and
- demonstrate that the amount of light affects what they can see.

CAUTION: Because too much exposure to the sun can be harmful, remind students to dress properly and use sunscreen when doing outdoor activities for long periods. Also, remind the children they should never look directly into the sun. Sunglasses are always a good idea.

Procedure

1. Take students outside on a sunny day and discuss where sunlight comes from and what it represents (sun's energy). Have students close and cover their eyes with their hands and ask them if they can see. Continue the discussion until students understand that we need light to see. Discuss the difference between night and day. How do colors compare in the night versus in the day? Why do students think this is?

2. Proceed with the Mystery Box demonstration to reinforce the idea that light from the sun enables us to see. Depending on the number of Mystery Boxes constructed, divide the students into groups and give a box to each. Tell the students they are going to investigate how levels of light—no light, a little light, or a lot of light—affect what they can see.

3. Have them hold the box up toward the sky and look through the pencil hole (but not directly at the sun). Ask them how much light is coming through the hole. Ask them to try to identify the object inside. If they cannot, ask them why.

4. Ask students to flip down the cardboard flaps to expose the waxed paper and look through the pencil hole. How much light is coming through now? Can they identify the object? If so, what color is it? If not, why can't they identify the color of the object? Light can pass through the waxed paper, but it is diffused so objects cannot yet be seen clearly.

5. Ask students to take off the second layer, leaving only the clear wrap. Ask them how much light is entering the Mystery Box now. Can they identify the color? Why can they identify the color with the see-through plastic, when they could not with the waxed paper?

6. Have students collect items from the schoolyard or classroom and test their properties by shining a flashlight behind the object and noting whether there is no light, a little light, or a lot of light shining through. Have them describe or illustrate in their ***Energy Learning Logs*** what the presence of sunlight means and describe or illustrate examples of the items they collected.

Assessment

- Have students describe the importance of light.
- Have students describe how objects appear in varying amounts of light.

Extensions

To reinforce the idea that light from the sun enables us to see, have students use a dark crayon to draw or trace simple pictures on sheets of light-colored construction paper. Make sure the objects they draw cannot be seen from the reverse side of the construction paper until you place the paper against a window. Display the sheets against the wall or the blackboard, blank side out. Ask the children if they can see the pictures they have drawn. Finally, place the sheets against the window glass with the blank sides out. The children should be able to see the pictures easily. Have them identify the various objects.

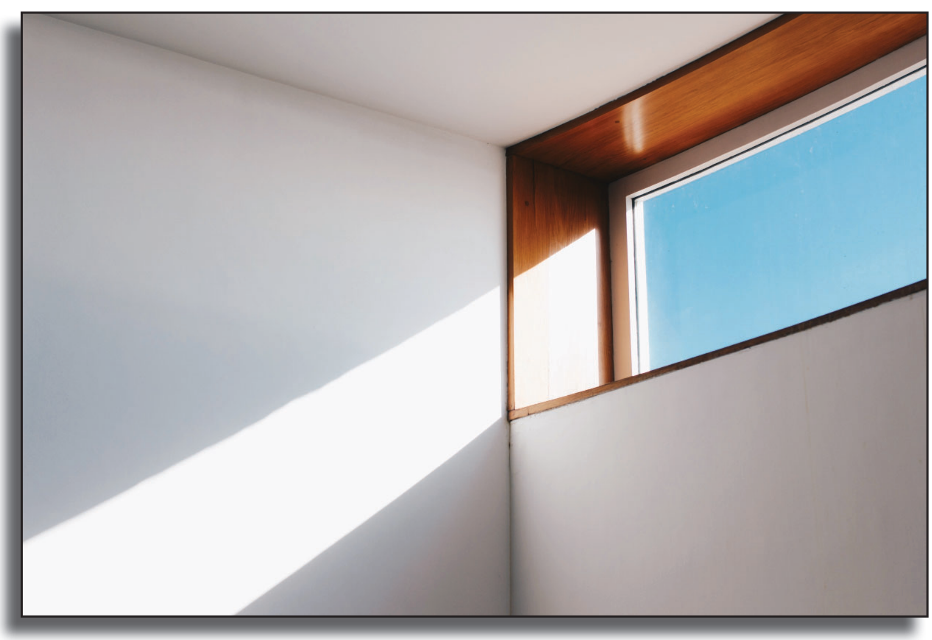
New buildings are often designed to take advantage of natural light so that artificial lights don't have to be used during the day. Take a field trip and explore the difference between a building that uses daylighting and one that does not.

Create a shade line to continue exploring colors (e.g., have the students gather leaves in various shades of green and arrange them in order from dark to light). Talk about how the sun affects color. Hand out prisms and have the students look at the light spectrum. This can be an opportunity to learn more about rainbows.

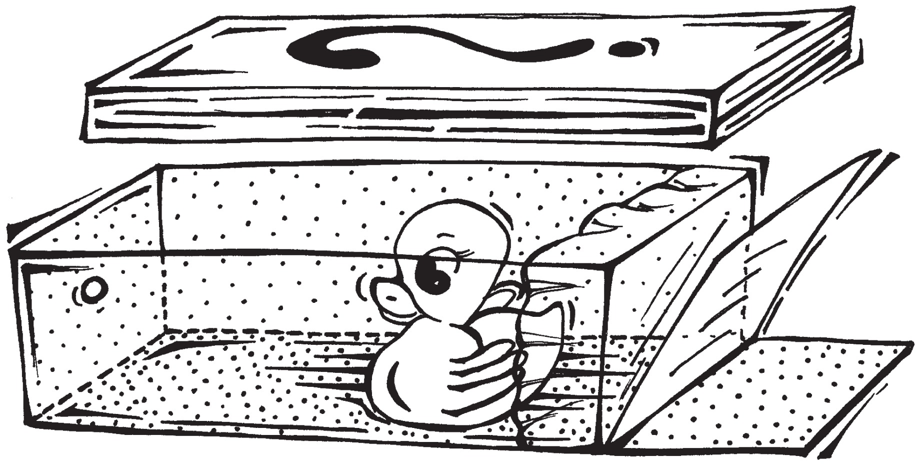
The Mystery Box can be used to demonstrate that various objects or materials have transparent, translucent, and opaque properties. Opaqueness (the quality of blocking the passage of radiant energy, especially light) can be introduced by explaining that light is not able to pass through the cardboard. Translucency (the quality of transmitting and diffusing light so that objects beyond cannot be seen clearly) can be introduced by explaining that the waxed paper diffuses the light. Introduce transparency (the quality of being able to transmit light so that objects lying beyond can be seen clearly) when the clear plastic layer is exposed.

Mystery Box Assembly Notes: To ensure desired results, when the Mystery Box is assembled correctly, make sure it is dark enough inside that the colored object can't be identified. With the cardboard flap open and the waxed paper exposed, the students should be able to identify the object but not its color. With the waxed paper removed and the clear plastic exposed, the student should be able to identify both the object and its color.

Depending on their dexterity, students can make the Mystery Boxes and put an item inside. Students can trade boxes to try to guess the item.



Mystery Box Assembly Instructions



Materials

- Shoebox
- Pencil
- Scissors
- Tape
- Clear plastic wrap
- Two or three sheets of waxed paper
- Small objects in a variety of colors
  (e.g., small toy, box of raisins, crayons, etc.)

Directions

- Poke a peephole in the center of one end of the shoebox with a pencil.
- Remove the lid. With the scissors, cut the other end of the shoebox so it hangs open, remaining connected at the bottom like a flap.
- Tape a sheet of clear plastic securely over the open end.
- Take the waxed paper and tape it onto the open end of the shoebox. You may need to use more than one piece to effectively diffuse the light. Be sure the flap is still able to be closed with tape and that the waxed paper can eventually be removed.
- Secure one of the colored objects to the bottom of the shoebox near the opposite end of the peephole.
- Replace the lid and close the cardboard flap of the box.

Shadows in the Schoolyard

Summary:
Students measure shadow lengths to appreciate how the sun's height and location in the sky varies throughout the day.

Objective

- Students will demonstrate that the sun's position in the sky determines shadow length and direction.

CAUTION: Because too much exposure to the sun can be harmful, remind students to dress properly and use sunscreen when doing outdoor activities for long periods. Also, remind the children they should never look directly into the sun. Sunglasses are always a good idea.

Procedure

1. Tell students they are going to investigate "The Mystery of the Schoolyard Shadows" (embellish the story as desired; you can play the part of a person who keeps losing his or her shadow). Explain that the shadows in the schoolyard keep changing throughout the day and they must help to solve this mystery. Ask them what they think happens to shadows, and have them write the answer in their ***Energy Learning Logs***. Ask them to predict when the shadows will be longest and when they will be shortest.

2. Find a sunny, flat area near your school. Orient students to north and review how to use a ruler as needed. NOTE: To help younger students understand directions, you might want to orient them to a landmark in the schoolyard, such as a tree or a building that is north of them. They can use this landmark as a reference point. For measuring they can use a string, a piece of yarn, or another adapted measuring tool. Students can then draw the length of string on a wall chart to measure shadow length and identify the schoolyard landmark to record shadow direction.

3. Choose an object that will cast a shadow that is easy to measure. The object can be a mailbox, pole, or piece of playground equipment, or you (the teacher). At various times of day, have the students go outside and measure the length of the assigned object's shadow with a yardstick or string, recording the length and direction of the shadow and the time of day in the ***Schoolyard Shadow Table.*** After each measurement, have students compare it to the previous measurement and predict how the shadow will be cast next time. See if they notice a pattern.

4. Have students look at the table to determine if they predicted correctly. Why does the shadow change throughout the day? Continue to investigate this case for at least a week. Are the shadows the same day after day?

5. Were students able to solve the mystery of why the shadows change throughout the day? The students that worked together can present their findings as a group, or the entire class can work together to solve the mystery. Continue the discussion until students understand that the sun appears to be positioned differently in the sky during the day due to Earth's rotation (i.e., be sure students understand that the sun is stationary while it is our planet that is moving). Earth's orbit changes during the different seasons, which also seems to change the position of the sun.

Assessment

- Have students collect data throughout the week, record their findings in their ***Energy Learning Log***, and use the information to compile the ***Energy Flow Mural***.
- With a drawing or a play, have students demonstrate the sun's position in the sky and the change in shadows throughout the day.

Extensions

Repeat these activities over the course of the school year. Have the students keep a seasonal log to track the data obtained and to look for patterns.

Grade Levels: K-4

Subject Areas: Language Arts, Mathematics, Earth and Physical Science, Environmental Literacy & Sustainability

Setting: Outdoor site where there are shadows that can be measured

Time:
Preparation: 20 minutes
Activity: 50-minute period plus time needed for shadow measurements throughout the day

Vocabulary: Light, Shadow, Solar energy, Sun

Standards Addressed:
CC ELA: L.4.2.D, L.4.3.A-B, RI.K.1&3&10, RI.1.3&5, RI.2.5, RI.3.3-5, RL.K.1&10, SL.K.1-6, SL.K.1.A, SL.1.1-6, SL.1.1.B-C, SL.2.1-2, SL.2.1.A-C, SL.2.4, SL.2.6, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, SL.4.5, W.K.1-3&8, W.1.1-3&8, W.2.1&3&8, W.3.1.B&D, W.3.7, W.4.1.B-C, W.4.2.D-E, W.4.3.D-E, W.4.7

CC Math: MP5, 2.MD.1-5

NGSS: 1-ESS1-1
SEP: Planning and Carrying Out Investigations
DCI: ESS1.A: The Universe and its Stars
CCC: Patterns

EL&S: Connect: C1.A.i, C1.C.e, C1.C.i
Explore: EX2.A.e, EX2.A.i, EX5.B.e

Materials:
- ***Energy Learning Log*** and writing implements
- Piece of schoolyard equipment, a tree located in an open area
- Compass (optional)
- Rulers
- Copies of ***Schoolyard Shadow Table***

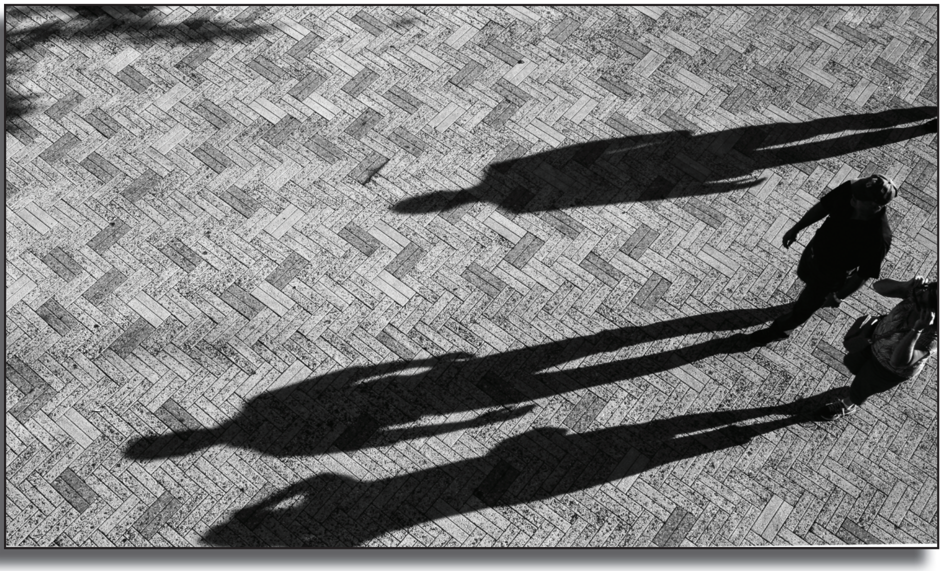
Continued next page

Related KEEP Activities:
To investigate how shading, coloring, and other factors affect temperature, refer to "Taking Temperatures." Refer to "Exploring Heat" and "Shoebox Solar Cooker" to help students understand heat and thermal properties of sunlight. Energize students by exploring light energy through the use of mini solar panels. To generate ideas on how to power up radios, toys, and more in your classroom, refer to "The Miracle of Solar Cells." To further explore the heat and light properties of the sun, refer to KEEP Energy Sparks "Exploring Light Energy" and "Exploring Heat." Available at keepprogram.org.

Investigate what happens to the length of shadows in your schoolyard in the morning, afternoon and evening by having students trace other classmates' shadows on large pieces of butcher paper. Compare the proportions.

Compare the time of day and where on the horizon the sun sets in summer, fall, winter, and spring. Is there a relationship between outside temperatures and sun height in the sky? What do people wear each season in response to temperature changes? Have the students create a collage or perform a fashion show that illustrates the various kinds of clothing people wear during different seasons.

Use the sun to determine which direction (north, south, west, or east) the front of your school faces. Which part of the school faces the sun when it rises? Label the east and west sides. Which side or part of your school is always in the shade? This is the northern side.



What the Sun Does for Me

Schoolyard Shadow Table

Date	Time	Shadow Length (inches)	Shadow Direction (N, W, E, S)	Change since last measurement (inches)

Unit 2
Energy from the Wind

Activities

Unit Objective

- Students will be able to illustrate how wind flows through their school.

Background

The sun is the primary source of energy, and it influences many activities on Earth. The sun heats Earth's surface, and the energy is re-radiated, warming the surrounding air. The warm air is less dense (the molecules are more spread out) and cooler (more dense air) flows in and displaces warmer, lighter air. This movement of air masses is one of the causes of wind. Therefore, the sun helps create wind. Both a feather floating in the breeze and a tornado blasting through the countryside illustrate that wind has energy. Of the sun's energy that reaches Earth, about two percent is converted to wind energy.

Wind energy has been used for hundreds of years. Farmers and ranchers have used windmills to pump water to fields and livestock in remote locations. Today wind machines provide electricity for operating lights and appliances and mechanical power for pumping water.

For information about the wind, see ***Refreshing Refrigerator Experiment*** in the activity "What the Wind Does for Me." See also "Facts about Wind Energy" in the appendix of the KEEP *Energy Education Activity Guide* and the following KEEP activities and Energy Sparks available at keepprogram.org::

- Sun, Wind, Water
- Waterwheels, Windmills, and Turbines
- Windy Wonders

What the Wind Does for Me

Summary:
Students illustrate ways the wind contributes to their lives.

Objective

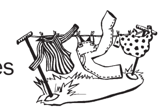
- Students will be able to identify ways that the wind contributes to their lives.

Procedure

1. Ask students to describe the wind and how they think wind is created; note their responses. See ***Refreshing Refrigerator Experiment*** to provide an introduction to wind formation. Have students share their ideas on the blackboard. Did they think of other ideas during the discussion? Add them to the list.

2. Hand out copies of ***What the Wind Does for Me*** activity sheet and have students generate ideas about ways the wind affects them. Students can keep the handouts in their ***Energy Learning Logs***.

Example:

The  dries 

The  feels cold on my face.

NOTE: Preliterate students can construct pictures using art supplies.

3. Take students outside and have them use all of their senses to describe wind. Can they see wind? Feel it? Smell it? Hear it? Taste it? How do we know it is there? What evidence can they provide to support their descriptions of wind? Have students record their findings in their ***Energy Learning Logs*** using the following descriptions:

Date of observation:
I can see:
I can feel:
I can smell:
I can hear:
I can taste:

4. After students have had time to describe wind individually, ask them to share their descriptions. Students should begin to look for patterns in these observations. Do their observations raise any additional questions? If so, record them in the ***Energy Learning Logs*** and discuss as a class.

5. Ask students to describe how hard the wind is blowing. Ask them how they can know if the wind is blowing softer or harder. What signs should they look for? Have students create a scale to categorize levels of windiness and signs they look for to identify each category. The ***Wind Scale Chart*** provides some suggested signs or references to gauge wind speed.

6. To celebrate the wind, have students create a wind chime. See ***Wind Chime Rhapsody.***

Assessment

- Have students list or draw jobs that the wind does for them and insert the information into their ***Energy Learning Logs***.
- Ask students how they discriminate between a gentle breeze and a strong wind.
- Challenge students to listen to the sounds of chimes in different levels of wind and to create their own wind scale.

Extensions

Students can create poems about the sensations they experience due to wind.

Students can physically interpret the various levels of wind and put on a short performance.

Take a tour to a wind generator and discuss how wind is used to generate electricity.

Have the students incorporate into the ***Energy Flow Mural*** the appropriate wind jobs they generated. Let students determine whether the wind jobs should be grouped or placed in various locations in the schoolyard or classroom on the mural.

Have students draw pictures in their ***Energy Learning Logs*** to illustrate what happens in their schoolyard during windy days and calm days.

Students can act out various wind speeds by imitating the wind instruments or tree branches and leaves blowing.

On days when students detect the wind is stronger, have them construct simple paper flying machines and hold a contest to see which one flies the farthest.

Grade Levels: K-4

Subject Areas: Language Arts, Earth and Physical Science, Environmental Literacy & Sustainability, Art

Setting: Classroom or outdoor work area

Time:
Preparation: 20 minutes
Activity: 50-minute period

Vocabulary: Sun, Wind, Molecule, High-Pressure System

Standards Addressed:
CC ELA:L.K.5.D, L.K.6, L.1.5.B, L.1.6, L.2.3, L.2.5.A-B, L.2.6, L.3.3, L.3.5.B, L.4.3, RI.2-4.3, RI.3.4, RI.2-4.10, RL.4.1, SL.K.1.A, SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2&5, SL.3.1.A-B&D, SL.3.5-6, SL.4.1.A-D, W.K.2&8, W.1-4.2, W.2.7, W.3-4.1.A

NGSS: K-ESS2-1
SEP: Analyzing and Interpreting Data
DCI: ESS2.D: Weather and Climate
CCC: Patterns

EL&S: Connect: C1.A.e, C1.A.i, C1.C.e, C1.D.e
Explore: EX2.A.e, EX3.B.e, EX4.A.e, EX5.B.e

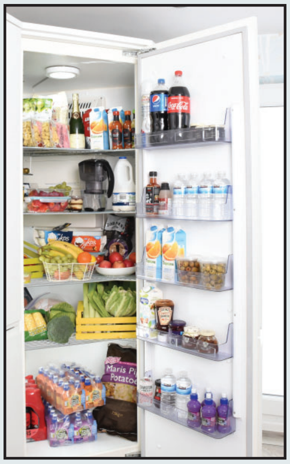
Materials:
- Copies of ***What the Wind Does for Me*** activity sheet
- ***Energy Learning Log*** and writing implements
- Copies of the ***Wind Scale Chart*** and ***Wind Chime Rhapsody***

Related KEEP Activities:
In "Sun, Wind, Water" students use art skills to emphasize the role of energy in the water cycle. For more fun sun activities, check out the KEEP Energy Spark "Windy Wonders." Available at keepprogram.org.

Refreshing Refrigerator Experiment

Does this sound familiar? It is unbearably hot outside so you go inside and open the refrigerator or freezer to get a cool drink, and you feel the cold, refreshing air rush out. An experiment for kids to try at home to learn more about wind is the ***Refreshing Refrigerator Experiment***. On the next warm day, tell the students to note where they feel the cold air when they open the refrigerator. If they were wearing shorts, they should have felt the cold air move over their legs and feet. What the students felt is “wind!”

Have the class talk about why they think the cold air moves out of the refrigerator, and why the warm air doesn’t seem to move in. Explain that like all material, air is made up of tiny particles called molecules. The cold air molecules are closer together and will sink because they are pulled by gravity. Warmer air is less dense, so it is more active and its molecules are more spread out. Ask students what heats the air and makes it warm (the sun).



Explain that depending on its location (e.g., over water, land, farms, and cities), air heats up at different rates so there is warmer and cooler air. Cooler air is denser and can displace warmer air, creating wind.

NOTE: Air moves from high pressure to low-pressure areas, meaning the cold, heavier air (high-pressure system or more dense air) “flows” in and displaces the warm air (low-pressure system or less dense air). The movement of air between pressure systems is one factor that causes wind. The greater the difference in air pressure, the harder the wind blows. In the Northern Hemisphere, wind flows clockwise around high-pressure systems and counterclockwise around low-pressure systems.

What the Wind Does for Me

Generate ideas about jobs the wind does for you.

Example: The  dries my 

1. The  ______________________________

2. The  ______________________________

3. The  ______________________________

4. The  ______________________________

5. The  ______________________________

What the Wind Does for Me

Wind Scale Chart

Wind Level		Signs	Student-Suggested Signs
1. Calm		Smoke goes up	______________
2. Gentle Breeze		Leaves rustle	______________
3. Moderate Wind		Flags flap and paper flies	______________
4. Strong Wind		Large branches move	______________

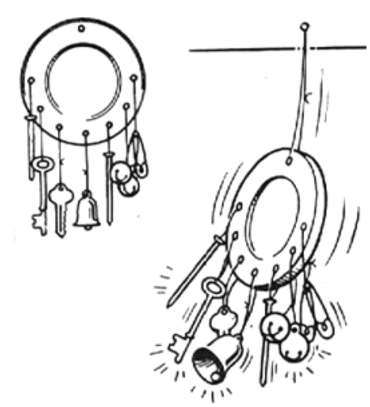
Wind Chime Rhapsody

Materials

- Yarn, cord, or fish line
- Metal items to attach to wind chime, such as nails, old utensils, clean tin cans. (Be very careful that children do not cut or poke themselves with sharp edges.)
- Wire coat hanger or piece of wood

Instructions

1. Cut yarn or cord in various lengths between 8 and 14 inches.
2. Tie a different metal item to each length of yarn or cord. Tie yarn, cord, or fish line to hanger so the items touch when the wind blows.
3. Hang wind chimes in a breezy location and listen to the wind chime rhapsody!



Schoolyard Breezes

Summary:
Students build and use simple wind measurement instruments to record air movements in their schoolyard.

Grade Levels: (K-2) 3-4

Subject Areas: Language Arts, Mathematics, Earth and Physical Science, Environmental Literacy & Sustainability, Art, Social Studies

Setting: Various stations set up throughout the schoolyard

Time:
Preparation: 20 minutes
Activity: 50-minute period for each outdoor visit

Vocabulary: Anemometer, Force, Temperature, Thermal, Wind vane

Standards Addressed:
CC ELA: L.K.1.D, RI.3.3-4, SL.K.1&3-6, SL.1.1.B, SL.1.3-6, SL.2.1.A-C, SL.2.2&4&6, SL.3.1.D, SL.3.6, SL.4.1.C-D, SL.4.5, W.K.2&7-8, W.1.2, W.2-4.7, W.4.2.D

CC Math: MP5, MP6, MP7

NGSS: K-PS2-1, K-ESS2-1, 3-ESS2-1
SEP: Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Constructing Explanations and Designing Solutions, Connections to Nature of Science, Scientific Investigations Use a Variety of Methods, Science Knowledge is Based on Empirical Evidence
DCI: PS2.A: Forces and Motion, PS3.C: Relationship Between Energy and Forces, ESS2.D: Weather and Climate, ETS1.A: Defining and Delimiting an Engineering Problem
CCC: Patterns, Cause and Effect, Connections to Engineering, Technology, and Applications of Science, Interdependence of Science, Engineering, and Technology, Influence of Engineering, Technology, and Science on Society and the Natural World, Connections to Nature of Science, Science is a Human Endeavor

EL&S: Connect: C1.A.i, C1.B.e, C1.C.e
Explore: EX2.A.e, EX3.B.e, EX4.A.i, EX5.B.e

Continued next page

Objective

- Students will be able to observe and measure the wind outdoors.

Procedure

1. Ask for students' ideas about wind and about how to observe wind activity. Help students narrow their observations to direction and speed. Tell students they are going to act as weather people and record and report on the wind in their schoolyard using a variety of simple wind tools that measure direction and speed. Tools will include a wind vane, wind direction indicator, pinwheel, anemometer, and a protractor wind speed indicator.

2. To measure wind speed, students will need to develop a scale to gauge the pinwheel and anemometer for calm, gentle, moderate, and strong categories (see ***Wind Scale Chart*** in "What the Wind Does for Me"). The protractor wind speed indicator has a scale but it may be too advanced for some students. Students might want to use the wind chimes they made in the ***Wind Chime Rhapsody*** in the activity What the Wind Does for Me.

3. Have a prototype of the weather instruments available for students to observe. Students should generate ideas about what they think each tool measures and why measuring that property of wind is important.

4. Take the class outside and review the direction orientations with students (north, south, east, and west). NOTE: To help younger students understand directions, you might want to orient them to a landmark in the schoolyard, such as a tree or a building.

5. Model the wind direction tools and the wind speed tools to the class. Introduce students to the ***Wind Scale Chart***. It might be helpful to create student sheets to ensure that everyone is following the same method of recording (see ***Schoolyard Breezes Recording Sheet***).

6. Divide the class into groups and assign each group to different locations around the schoolyard (four to five weather stations are recommended). Instruct each group to make a wind direction instrument and wind speed instrument at their location. Students can record their findings in the ***Schoolyard Breezes Recording Sheet*** and their ***Energy Learning Logs***. Repeat the wind measurements daily throughout the week. If possible, do the measurements two to three times a day.

7. Discuss with students how wind is an example of a force that can push or pull. Have students describe how the force of the wind affected each of the measuring tools. Include discussion about how wind speed and direction affected each of the tools.

8. At the end of the week students should look back through the ***Energy Learning Logs*** and discuss their findings. Did they notice any patterns in the wind? Is it windier during certain times of the day or under certain weather conditions?

9. Once students have measured the wind patterns and speed around the schoolyard have them present to the class a mini weather report with the data they have gathered in their ***Energy Learning Logs.*** They can also diagram the schoolyard to note wind patterns according to their ***Energy Learning Logs***.

Assessment

- Have students identify and construct various simple wind-measuring devices and accurately explain what wind property each instrument measures.
- Have students log simple wind measurements and report their findings to the class.
- Have students diagram the wind patterns around the schoolyard and think about where they could stand to either feel the wind or stay sheltered from it.

Materials:

- ***Wind Scale Chart***
- Material to construct wind instruments (see ***Wind Instrument Construction***
- ***Energy Learning Logs*** and writing implements
- ***Schoolyard Breezes Recording Sheet*** (optional – see example)
- Weather thermometer set up at each weather station (optional)
- Compass (optional)

Related KEEP Activities:

In "Waterwheels, Windmills, and Turbines" students construct simple turbines to investigate how the energy in wind power can be harnessed to do work. Available at keepprogram.org.

Extensions

Have students make a picto- or bar graph of their data.

Students can take other measurements, such as cloud cover and temperature, at the weather stations.

Have students watch the evening weather to determine if their readings are similar to the local meteorologist.

Have students use the measuring tools during different seasons and compare patterns.

Invite a local meteorologist to class to discuss wind patterns and wind-measuring devices.

Take a tour to a weather station or wind generator.

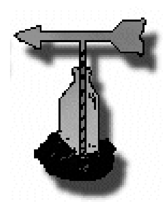
Discuss how early explorers and modern travelers use the wind to sail across bodies of water. Investigate different types of sails and have students make simple sailboats. Try similar investigations with air travel (gliders and hot air balloons).

Have students incorporate the diagrams, pictures, and data of wind speed in the schoolyard into their ***Energy Flow Mural***.

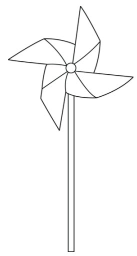
Ask students if they have ever seen a bird soaring through the air. Ask them how the birds do this. Explain that wind is not only close to the ground but also high in the air, and teach a lesson on thermal air currents.

Wind Instrument Construction

Possible Wind Direction Tools:
wind vanes, wind direction indicators



Possible Wind Speed Tools:
pinwheels, anemometers, and wind chimes (See ***Wind Chime Rhapsody*** in "What the Wind Does for Me").



To measure wind speed, students will need to develop a scale to gauge for calm, gentle, moderate, and strong categories (see ***Wind Scale Chart*** in "What the Wind Does for Me").

More advanced students might want to try the protractor wind speed indicator from the KEEP E*nergy Education Activity Guide* (in the activity "Siting for Solar and Wind Energy") available at keepprogram.org. NOTE: The wind scale can be adapted for young students by using calm, gentle, moderate, and strong to replace the numbers.

Wind instrument designs and instructions are found on pages 21-25. Many additional options can be found on the Internet.

Schoolyard Breezes Recording Sheet

Weather Station # __________ **Measuring Tool** __________________________

Date ______________________ **Time** _________________________

Diagram of Schoolyard and Weather Stations

N

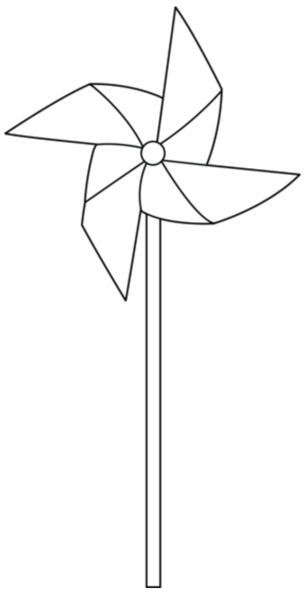
	Circle One			
Wind Direction	N	S	E	W
Wind Speed	Calm	Gentle	Moderate	Strong
Temperature (optional)				
Cloud Cover (optional)	○	◔	◑	●

Wind Instrument Construction

Pinwheel Wind Collector

Materials:

- A straight pin
- A square piece of construction paper (about 8.5” x 8.5”)
- A sharpened pencil with an eraser
- Scissors



Procedure

Lay the square of paper flat on a table and draw a line diagonally from each corner to the opposite corner. Mark the center of the square where the two lines cross and punch a small hole through it with the pencil tip. Next, cut along each line, stopping about an inch from the hole in the center of the square. Take the straight pin and punch a hole in the top left corner of each of the four flaps. (No two holes should be next to each other.) Pick up a flap at a punched corner and carefully curve it over toward the center hole, securing it with the straight pin. Repeat this for the other flaps. When all four flaps are held by the straight pin, carefully lift the paper without letting the flaps unfurl. Lay the pencil flat on a table and carefully push the point of the straight pin into the side of the eraser.

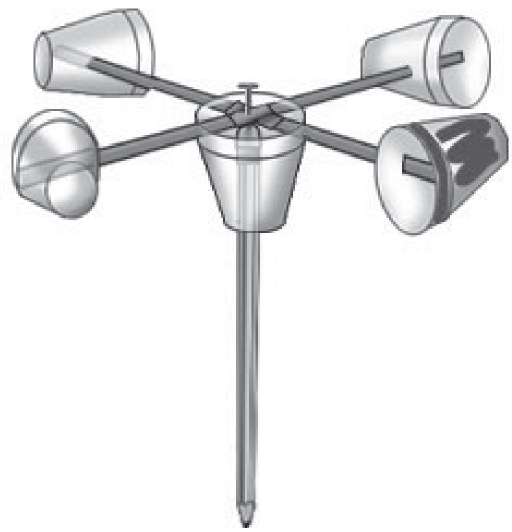
Now your pinwheel is complete and ready to go. Pick up the pinwheel near the pencil point and let it catch the wind. Notice that the pinwheel only spins when the wind hits its center.

You now have a simple wind collector. The pinwheel is an example of a horizontal-axis active wind collector. It must be pointed into the wind in order to spin.

Wind Instrument Construction

Anemometer

Materials:



- Five 3-ounce paper drinking cups
- Two straight plastic soda straws
- One straight pin
- Scissors
- Small stapler
- Sharp pencil with an eraser
- Paper punch

Procedure

Take four of the paper cups. Using the paper punch, punch one hole in each, about a half inch below the rim.

Take the fifth cup. Punch four equally spaced holes about a quarter inch below the rim. Then, using a pencil, punch a hole in the center of the bottom of the cup.

Take one of the one-hole cups and push a soda straw through the hole. Fold the end of the straw, and staple it to the side of the cup across from the hole. Repeat this procedure for another one-hole cup and the second straw.

Now slide one cup and straw assembly through two opposite holes in the cup with five holes. Push another one-hole cup onto the end of the straw just pushed through the five-hole cup. Bend the straw and staple it to the one-hole cup, making certain that the cup faces in the opposite direction from the first cup. Repeat this procedure using the other cup and straw assembly and the remaining one-hole cup.

Align the four cups so that their open ends face in the same direction (clockwise or counterclockwise) around the center cup. Push the straight pin through the two straws where they intersect. Push the eraser end of the pencil through the bottom hole in the center cup. Push the straight pin into the end of the pencil eraser as far as it will go. Your anemometer is ready to use.

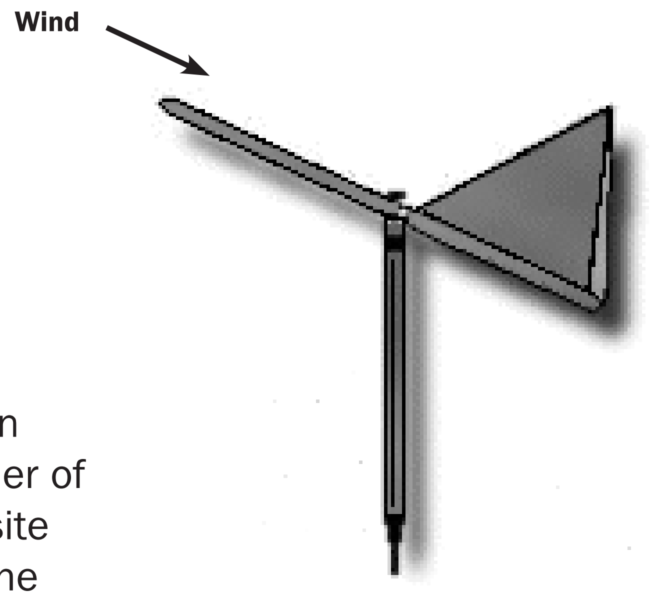
Your anemometer is useful because it rotates at the same speed as the wind. This instrument is quite helpful in accurately determining wind speeds because it gives a direct measure of the speed of the wind. To find the wind speed, determine the number of revolutions per minute. Next calculate the circumference of the circle (in feet) made by the rotating paper cups. Multiply the revolutions per minute by the circumference of the circle (in feet per revolution), and you will have the velocity of the wind in feet per minute. The anemometer is an example of a vertical-axis wind collector. It need not be pointed into the wind to spin.

Wind Instrument Construction

Wind Direction Indicator

Materials:

- One straight plastic soda straw
- One piece of construction paper
- A pencil with an eraser tip
- One straight pin
- Stapler
- Scissors



Procedure

Cut one end off the piece of construction paper so that it is square. Fold one corner of the square over until it meets the opposite corner to form a large triangle. Crease the fold and open the paper. Cut along the fold to make two triangles. Fold one triangle in half once again and crease it along the fold. Next place an open edge of this folded triangle over the soda straw with the point toward the center of the straw and the other open edge at the end of the straw. Staple the tail to the straw. Next push the straight pin through the soda straw about one inch ahead of the front of the tail. Push the straight pin into the top of the eraser on the pencil. Your wind direction indicator is now ready to use.

Hold the wind direction indicator in the wind. It automatically turns around until the **tail of the straw points away from the wind and the tip points into the wind**. This instrument is useful in determining where the wind is coming from at any time and in noting variations during the day or from season to season. Hold your wind direction indicator in the wind and notice how often the wind direction changes.

Wind Instrument Construction

Wind Vane

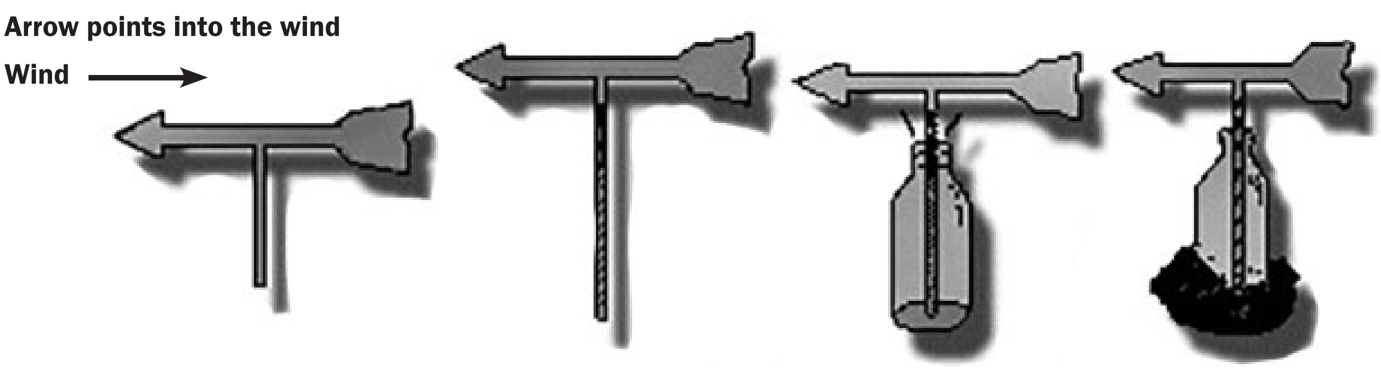
Before You Start

A weather vane is also called a wind vane. It is a tool for measuring wind direction. It spins on a rod and **points in the direction from which the wind comes**.

The weather vane is one of the oldest weather tools. The part of the vane that turns into the wind is usually shaped like an arrow. The other end is wide so it will catch the smallest breeze. The breeze turns the arrow until it catches both sides of the wide end equally. The arrow always points into the wind, telling you the direction from which the wind is coming. If the wind is blowing from the south, the wind is usually warm. If the wind is blowing from the north, the wind is usually cooler. The breeze turns the arrow on the weather vane until it catches both sides of the wide end equally.

Materials:

- Paper and pencil
- Scissors
- Cardboard
- Compass
- Plastic soft drink bottle
- Plastic drinking straw
- Shallow pan filled with rocks
- Felt-tipped marking pen



Procedure

Ask students what a weather vane is, and where they have seen weather vanes. Write down their answers. Ask them to draw a picture of a weather vane.

Have students carefully cut an arrow with a tab from the cardboard, as shown. If the end opposite the arrow is longer and wider than the arrow, it will work better. Remind students that scissors are sharp, so they must handle them carefully. Have them bend

Wind Instrument Construction

the tab slightly so the arrow turns easily when you put it in one end of the straw. They can put the other end of the straw in the bottle. Have them remove enough rocks from the pan to make room for the bottle and pile the rocks back around the bottle so it won't be blown over. (See illustrations above.)

A compass always points north. Have students use their compass (or schoolyard landmark) to find north, and then mark the four sides of the bottle E, W, N, and S with a felt-tipped pen.

Have students set their wind vane in a high place such as the top of a playhouse or a slide. Make sure that it does not wobble or tilt and that it is unobstructed so it can catch the slightest breeze.

Have them watch their weather vanes closely and then describe how they work. Test them on windy days and again when there is just a light breeze.

Background Information

A weather vane is a tool used to tell which direction the wind is coming from (many people mistakenly think the vane points in the direction the wind is going). This information can be useful in a number of ways; for example, early explorers needed to know what direction the wind was coming from to sail their ships, which helped them sail to America. Weather vanes are usually found on top of buildings so they will catch an open breeze. Look for them on top of barns, houses, weather stations, hardware stores, and other places that sell or use weather tools. The part of the vane that turns into the wind is usually shaped like an arrow. The other end is wide so it will catch the smallest breeze. Sometimes a metal rooster or other animal sits on top of the weather vane.

Some weather vanes have directional strips underneath the arrow to make it easier to read. Your markings on the bottle do the same thing.

It is easier to see how the energy from the wind moves your weather vane if it is up high and in an open area. You might also want to experiment by putting it on the ground.

Although a weather vane is one of the oldest weather tools, it is still used today to measure the direction of the wind. Weather vanes can only measure wind direction a few yards (meters) off the ground. Large, helium-filled weather balloons are used to measure winds high above Earth's surface. The balloons move with the same speed and in the same direction as the wind.

Mapping Wind in the Classroom

Summary:
Students map air movements in their classroom by using simple tools to detect drafts.

Grade Levels: (K-2) 3-4

Subject Areas: Language Arts, Mathematics, Earth and Physical Science, Environmental Literacy & Sustainability, Art, Family Living and Consumer Education

Setting: Classroom

Time:
Preparation: 5 minutes
Activity: 50-minute period

Vocabulary: Air filtration, System, Temperature, Wind

Standards Addressed:
CC ELA: L.K.1.A&D, L.K.2.A, L.K.4, L.K.5.A, L.1.1.A&G-H, L.1.2.A-B&D-E, L.1.5.A-B, L.K-1.6, L.2.1-3&6, L.3.1-2, L.3.2.E-F, L.4.1, L.4.1F, L.K-2.6, L.1.5.B, RI.2.3&10, RI.3.3-4&10, RI.4.3&10, SL.K.1.A, SL.K.3-4&6, SL.1-2.1.B-C, SL.2.2, SL.3.1.A-D, SL.3.6, SL.4.1.A-D, W.K.2&8

CC Math: MP5

NGSS:K-PS2-1, K-ESS2-2
SEP: Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Engaging in Argument from Evidence
DCI: PS2.A: Forces and Motion, PS2.B: Types of Interactions, PS3.C: Relationship Between Energy and Forces, ESS2.E: Biogeology, ESS3.C: Human Impacts on Earth Systems
CCC: Cause and Effect, Systems and System Models

EL&S: Connect: C1.A.i
Explore: EX2.A.e, EX5.B.e, EX5.B.i
Engage: EN6.A.i

Continued next page

Objective

- Students will identify and record air movements in the classroom.

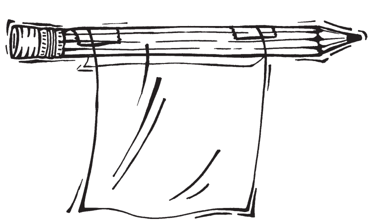
Procedure

1. Now that students have measured wind outside the classroom, ask them if they think that wind can occur indoors. Ask for students' ideas about where wind occurs indoors and how it happens. Make sure students understand that rooms can experience wind through air currents or drafts. Tell students that they are going to investigate wind in their classroom.

2. Model how students should use these items to detect currents indoors, or ask students to provide suggestions.

- Drop the feathers, letting them fall to the ground, or gently blow the bubbles and watch where they go. Do they fall straight down or do they float in a certain direction?
- Drape a thin piece of plastic sheet lengthwise over a pencil (secure it with tape if necessary) and hold very still. Does the plastic move?

NOTE: To ensure results, demonstrate with a fan on low setting.



Ask students why the air moves the bubbles, feather, and plastic. Remind them that air is a force that can push or pull things. Ask students why the air in the classroom sometimes moves fast and sometimes moves slow. Help students figure out what causes the air to move in the classroom (fan, furnace, their movement, etc.). Point out that everything causing the air to move is driven by some form of energy.

3. Divide students into groups and assign each group to various stations around the room where students can research air currents and drafts (near windows and doors, over a heater, in the center). Each group should be equipped with feathers, bubbles, pencils, plastic sheets, and tape.

4. Provide each group with a piece of chalk or a paper arrow. Have them test for air currents and draw or place an arrow on the ground indicating the direction of the air flow. Have students record their observations at their stations in their ***Energy Learning Logs*** and share their findings with the class. The class should determine if the wind is from a heater, fan, or air conditioning, or if it is a current from a window or door (even if windows and doors are closed students can check for drafts).

5. Create an aerial diagram of your classroom. Show students the diagram and explain that it is a view from the top. Tell them to locate their stations on the diagram and to transfer the arrows they placed on the floor to the diagram to show air current flows in the classroom. This step might help them identify sources of drafts.

6. Discuss with students that the air movement in the classroom is an example of a "system." This particular system was designed by people to make their living space more comfortable.

Assessment

- Have students describe where air currents and drafts come from.
- Have the class compose a classroom wind map and have students include it in their ***Energy Learning Logs***. This map can be used to help construct the ***Energy Flow Mural*** at the end of the unit.

Extensions

It is important to control drafts in the classroom (or at home) when trying to cut down on heating costs. To engage students in energy-saving ideas, have

Materials:

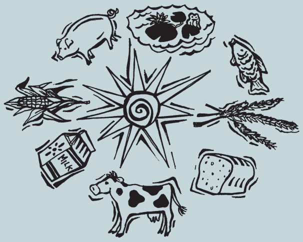
- Feathers
- Bubbles
- Pencil
- Strips of plastic wrap or strips from a plastic bag
- Tape
- Fan (optional)
- Pieces of chalk or paper arrows
- Diagram of classroom
- ***Energy Learning Log*** and writing implements

Related KEEP Activities:

As an addition to this activity, "Be an Energy Saver," a KEEP Energy Spark, introduces students to other ways to save energy and develop wise energy use habits. Available at keepprogram.org.

them create their own draft doorstops. To do this, take a large sock and stretch it. Use markers or fabric paints to design a pattern. Be sure to let fabric paint dry before continuing. Fill sock with sand, beans, or foam rubber, and have teacher securely sew or tie end together. On the closed end, squeeze some beans into the shape of a snake's (or another animal's) head. Twist pipe cleaner around back of head to form a neck. Cut black and white circles to form eyes, and cut a red tongue. Glue eyes and tongue on sock. Take snake doorstops home and place on floor up against door to keep out drafts.

Students can learn about basic window insulation techniques by using a medium-sized corrugated cardboard box to symbolize a house. Let students decorate the box if they wish. Cut four windows and install the regular windows by covering the holes with plastic and sealing with tape on the inside of the house. To add the storm windows, tape another piece of plastic on the outside of the window. Explain to students that the air space between is what keeps the cold air from penetrating the house. This air space acts as a form of insulation. Discuss where other drafts might enter the house in the winter months (along the seams of the window) and how this can be prevented. Add another piece of plastic insulation to the inside of the house. Be sure this piece of plastic is larger than the regular window and covers the original window seams (tape) completely. Explain that this plastic insulation helps block drafts in the winter by keeping the cold air out and warm air in, which reduces heating bills.



Unit 3
Energy from Food

Activities

Unit Objective

- Students will be able to illustrate how energy from food flows through their school.

Background

Almost everything you eat can be traced through food chains back to the sun. A food chain consists of a series of organisms; the first organism is eaten by a second and the second is eaten by a third. During this process, nutrients and energy stored in the eaten organism are transferred to the organism that eats it.

Most of the food we eat comes from simple food chains derived from human-controlled agricultural ecosystems. For example, the beef we eat comes from a cow that ate corn. The corn received its energy from the sun.

Food chains begin with producers, organisms such as green plants that can make their own food. In photosynthesis, plants and other producers use solar energy to combine carbon dioxide and water molecules into a new molecule—glucose (oxygen is also produced as a by-product). The energy used in photosynthesis is converted to the energy stored in the chemical bonds of the glucose molecule. Of all the energy a plant receives from the sun, only about three percent is converted into chemical energy. (The amount of chemical energy varies depending on the plant species and the location of the plant.)

Plants are eaten by consumers, which are organisms that cannot make their own food. Herbivores are consumers that eat only producers. Carnivores are consumers that prey on other consumers. Omnivores are animals that can get energy by ingesting either producers or consumers.

See additional information in the following KEEP activities at keepprogram.org:

- Energy from Food
- Food Chain Game
- Roasted Peanuts
- Solar Energy and the Carbon Cycle

The "Sun"wich

Summary:
Students create simple food chains based on their lunch items.

Grade Levels: K-4

Subject Areas: Language Arts, Mathematics, Life Science, Environmental Literacy & Sustainability, Family Living and Consumer Education

Setting: Classroom

Time: Preparation: 30 minutes
Activity: 50-minute period

Vocabulary: Carnivore, Consumer, Decomposer, Energy, Food chain, Food web, Herbivore, Primary consumer, Producer, Secondary consumer, Solar energy, Sun, Thermal energy, Trophic level

Standards Addressed:
CC ELA: L.K.1.D&F, L.K.2&4-5.A, L.1.1&5.A, L.1.2.B, L.3.1.I, L.3.2, L.3.4.D, L.4.1.F, RI.3.3-4, SL.K.1&3-4&6, SL.1.1.B, SL.1.3-4, SL.2.1.B-C, SL.2.2, SL.3.1.D, SL.3.6, SL.4.1.C-D, W.K.2&8, W.4.2.D

CC Math: MP4, MP5, MP6, 1.MD.4, 2.MD.9, 3.MD.3

NGSS: K-LS1-1, 5-PS3-1
SEP: Developing and Using Models, Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
DCI: LS1.C: Organization for Matter and Energy Flow in Organisms, PS3.D: Energy in Chemical Processes and Everyday Life
CCC: Systems and System Models

EL&S: Connect: C1.A.i, C1.B.e
Explore: EX2.A.i, EX2.A.m, EX2.B.e, EX3.B.e, EX4.A.e

Materials:
- A ham (or other type) sandwich
- Pictures/models representing items in the sandwich and food chains (Optional; see NOTE in Step 2)
- ***Energy Learning Logs*** and writing implements

Related KEEP Activities:
The KEEP Activity "Energy from Food" is an ideal follow-up to this activity. Students learn how food is the fuel that our bodies use to move and grow. Encourage students to add humans to their food chains. Available at keepprogram.org.

Objective

- Students will be able to show that energy found in food originates from the sun.

Procedure

1. Show students the sandwich and ask them what it is. Tell them it is not just a sandwich but a "sun"wich as well. Ask them what they think you mean by this. Tell them the sandwich is made out of the sun. Point to the bread and ask them what it is made out of. Help them to understand that bread comes from wheat, which is a plant that uses the sun's energy to grow.

2. Challenge students to trace each food item in the sandwich back to the sun. For example, ham comes from pigs that eat corn, and corn uses the sun's energy to grow. NOTE: To make this activity more hands-on, have pictures or 3-D models of each food item students list (e.g., pictures of ham slices, pigs, corn, and the sun). The pictures can be drawn, cut from a magazine, or constructed from felt or other materials. Models can be made out of clay or various recycled materials.

3. Point out the pig, corn, and sun, and explain that these items constitute a food chain. Ask students for a good definition of a food chain. Work with them to write a one-sentence definition and write it on the board. Check to see that the statement references the sun. Have students record the definition in their ***Energy Learning Logs***. NOTE: To bring deeper understanding to the lesson and address more science standards, explain to students that a food chain is an example of a system. Help students identify where water and air fit into the system.

Assessment

- Set up "snack stations" around the room with items such as crackers, cheese, toast, etc. Have students create food chains for each station using drawings or cutouts from magazines (you might want to check their work before they move onto the next station). Have them illustrate food chains in their ***Energy Learning Logs***.
- Students can add their food chains to the ***Energy Flow Mural***. Have them make connections from the sun to plants to animals and to their school. They can use illustrations from magazines or use their school lunch as an example. See Extensions for other ideas.

Extensions

If the class is adding food chains to an ***Energy Flow Mural***, you might want to challenge them to consider what happens to the food and energy after they consume the food. We get energy from food through a process called respiration, which is a type of burning. Students can detect evidence of this process by feeling the thermal energy in their bodies. Help them understand that much of the energy from food leaves our bodies through heat transfers. You can also choose to have students learn about the school's waste disposal systems and how wastewater is treated. Another aspect to explore is what happens to uneaten food and investigate the possibilities of composting.

In the lunchroom, have students weigh or record the amount of food they throw away for one week. Discuss the implications of wasting food and suggestions for eating food more wisely. Tie this information in with a nutrition unit while discussing healthy eating habits. Students can also record the amount of packaging they generate. They can look into options of recycling materials, composting, and buying efficiently packaged materials. A compost bin provides useful information about decomposition and energy transfers. Contact your local solid waste agency or extension office about composting information and related lesson plans.

Detecting Schoolyard Food Chains

Summary:
Students research organisms in their schoolyard and create simple food chains involving those organisms.

Objective

- Students will be able to construct food chains that include organisms that live in their schoolyard.

Procedure

1. Review the definition of a food chain and provide simple examples if necessary (see "The 'Sun" wich activity).

2. Ask students what examples of food chains they might expect to find in their backyards. They might list insects eating plants that use the sun to make their food. Even if they do not witness an insect eating a plant or a predator (robin) eating a prey (worm), they can look for evidence of food chains.

3. Tell students that they are going to play "Food Chain Detectives" and look for schoolyard food chains. You might want to embellish the scenario by describing an investigation: The Case of the Missing Links. Be dramatic as you wish as you describe their mission to find proof that food chains are taking place all around them. Ask the class to suggest clues they might look for to prove that food chains exist in their schoolyard (e.g., plants nibbled by insects). Tell students that they can also look at an insect and guess what it might eat.

4. Take the class outside and divide students into pairs. Give each pair a clothes hanger and instruct them to place the hanger on the ground between them (depending on the maturity of your students, you can also have them carefully toss the hanger and go to where it lands to investigate).

5. Tell them to look for any evidence that food chains exist within the parameters of the hanger. Suggest that they find one or more organisms and look for clues that "link" it to other plants or animals in a food chain. They can look for plants that have been eaten or insects that have eaten something. You might want to let students dig to look for organisms underground. You can also invite students to look in trees and bushes to see what food chain organisms might be lurking there. If students are lucky, they might actually witness a food chain in action (such as sun shining on plants, a spider catching a fly, or a bird eating an insect).

6. Have each pair select one plant or animal to draw in their ***Energy Learning Logs***.

7. Return to the classroom and tell students that an important part of detective work is research. Have students find out more about their chosen plant or animal and where it fits within a food chain. They are looking for ways to fill in the "missing links" to complete a food chain. What does the animal eat? What, if anything, eats it? What else does an animal need to survive? Ensure they include water in their investigation. Point out that some insects do not need to drink water directly but they get it from the plants they eat. Discuss how the plants get the water. Depending on their skill level, students can look in reference books to try to identify their plant or animal. You might want to invite a middle or high school biology teacher or a local naturalist to help.

8. Lead students to construct food chains that include their organism, check to see that they include the sun. Students can record findings in their ***Energy Learning Logs.*** You might want to invite the art teacher to provide suggestions for using different mediums to create and draw the chains (e.g., felt board).

9. Now that the detectives have gathered their information, they need to report their findings to the class. Have they solved the Case of the Missing Links?

Assessment

- Have each pair of students present and describe their food chain to the class. If the class is making an ***Energy Flow Mural***, they can post their food chains on the mural.

Grade Levels: (K-2) 3-4

Subject Areas: Language Arts, Life Science, Environmental Literacy & Sustainability

Setting: Outdoor setting with a variety of habitat types

Time:
Preparation: Two 50- minute periods
Activity: One week

Vocabulary: Carnivore, Consumer, Decomposer, Food chain, Food web, Herbivore, Heterotroph, Primary consumer, Producer, Secondary consumer, Solar energy, Sun, Trophic level

Standards Addressed:
CC ELA: L.K.1.A&D, L.K.2.A, L.K.4&6, L.K.5.D, L.1.1.A&G-H, L.1.2.A-B&D-E, L.1.5.B, L.1.6, L.2.1-3, L.2.5.A-B, L.2.6, L.3.1, L.3.2.E-F, L.3.3, L.3.5.B, L.3.6, L.4.1.F, L.4.2.D, L.4.3.A-B, L.4.6, RI.K.1&3&7&10, RI.1.3&6, RI.3.4&7, RL.K.1&10, SL.K.1.A, SL.K.2-6, SL.1.1.A-C, SL.1.2, SL.1.4-5, SL.2.1.A-C, SL.2.2, SL.2.6, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, W.K.1-3&7-8, W.1.1&3&7-8, W.2.1&3&7-8, W.3.1.B&D, W.3.7, W.4.1.B-C, W.4.2.E, W.4.3.D&E, W.4.7

NGSS: K-LS1-1, K-ESS3-1
SEP: Analyzing and Interpreting Data, Developing and Using Models, Obtaining, Evaluating, and Communicating Information
DCI: LS1.C: Organization for Matter and Energy Flow in Organisms, ESS3.A: Natural Resources
CCC: Patterns, Systems and System Models

EL&S: Connect: C1.B.e, C1.C.e, C1.C.i
Explore: EX2.A.e, Ex2.A.i, EX2.B.e, EX2.B.i, EX3.B.e, Ex4.A.e, EX4.A.i, EX5.B.e

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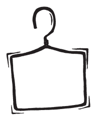
Materials:

- A section of the schoolyard or a nearby park that has plants, insects, and other animals
- Clothes hangers (one for each pair of students; stretch out the hanger to make a square)



- ***Energy Learning Logs*** and writing implements
- Small shovels (optional)
- Tools to explore school yard food chains, such as tweezers, magnifying lenses, paper cups (optional)
- Simple reference or picture books (e.g., insects, birds, plants)
- Drawing paper and crayons

Related KEEP Activities:

The KEEP Activity "Energy from Food" is an ideal follow-up to this activity. Students learn how food is the fuel that our bodies use to move and grow. Encourage students to add humans to their food chains. Available at keepprogram.org.

- Combine all the food chains to connect to a single sun; challenge students to see if they can find interconnections among their various food chains and create a food web.

Extensions

Students might be interested in making a living model of a food chain they found in the schoolyard. Have students bring in a large glass jar and poke holes in the lid. Put some soil and small plants in the soil (if time allows, students can try planting grass seed). Capture an insect such as a grasshopper or a caterpillar and observe it in the jar for a few days. Students can record their observations in their ***Energy Learning Logs*** and return the insects to the yard.

When people are learning about food chains, often the most important link of the chain—decomposers—is often overlooked. Decomposers consume and process all the nutrients and stored energy in waste products and uneaten materials. Help students appreciate the role of decomposers in a food chain by building mini food composters. Students can make mini composters by cutting clean, clear soda bottles in half and poking a few holes in the bottom. Add a mixture of soil and shredded newspaper strips and a few redworms. Add a half cup of fruit or vegetable food scraps. Cover entire bottle with black construction paper. Stir every other day for aeration. Feed the worms once a week or less.

- If redworms are trying to leave the bin, there might be too many worms or the compost might be too hot. Remove excess worms or stir bedding and moisten
- If compost smells there might be too much food, not enough aeration, or too much moisture. Remove old food and bedding and add fresh, moist bedding (moisture level should resemble that of a wrung out sponge).

Have students make daily observations and record how long various materials take to decompose. Encourage them to look for decomposers in the schoolyard soil. Students can make a field guide for their school, identifying decomposers and their valuable role. Remember that the most important decomposers, the bacteria, are microscopic.

Photosynthesis Promenade

Summary:
Students simulate the process of photosynthesis through a whole-body demonstration.

Objective

- Students will be able to illustrate how plants use the sun's energy to make food.

Background

Photosynthesis is the process by which green plants use sunlight to produce carbohydrates such as glucose, other nutrients, and oxygen from simple compounds such as water and carbon dioxide. In energy terms, photosynthesis converts solar energy into chemical potential energy that is stored in carbohydrates.

Photosynthesis occurs when water is absorbed by the roots of the plant and is then carried to the leaves. Carbon dioxide then enters the plant through the leaves and goes into the plant cells that contain chlorophyll. Chlorophyll is the green pigment found in the chloroplasts of plants that are essential for producing carbohydrates by photosynthesis.

Photosynthesis gives off oxygen and takes in carbon dioxide while people take in oxygen and give off carbon dioxide. This makes photosynthesis a great example of how people and plants depend on each other.

Procedure

1. Ask the class for one volunteer to share with the class what they ate that day or the previous day. Write the name of the student on the board and then write the things the student ate around it. Pick one of the foods the student ate (fruits or vegetables are easiest) and discuss with the class where that food came from. For example, if the student lists an apple, draw an apple tree on the board. Then ask students what the apple needs to grow. As students list things draw them on the board as well. The key item students should identify is the sun.

2. Put a picture of a rabbit on the board (or write the word) and ask students to complete a food chain around the rabbit. For example, they might show the rabbit eating a carrot that gets its energy from the sun and list a predator, such as a hawk, that eats the rabbit.

3. Have students explain what is happening between the links of the food chain, starting between the predator and the prey. They will probably be able to describe how the hawk eats the rabbit and the rabbit eats carrots, but how do they explain the connection between the sun and the carrot (or any plant)?

4. Ask students how they know plants need sunlight. Have students share their observations and thoughts about plants needing the sun. For example, students may have noticed how some plants turn their leaves toward the light. To fully address the science standards in this lesson, involve students in an investigation in which they prove plants need sunlight to survive. See ***Suggested Sun Test Procedure*** on the next page for ideas.

5. Students might know that plants need sunlight, but do they know how plants use the light? Have students provide explanations for how they think plants use sunlight. List their responses on the board.

6. Explain to students that sunlight helps the plant take air particles (carbon dioxide) and water and recombine them to build sugar particles (or molecules). Oxygen that we breathe is also created in the process.

7. Introduce the term photosynthesis. Students should recognize the root word "photo." Ask what they think it means. Help them understand that it means light. Students might also have heard the word synthesis or a related term, such as synthetic. Explain that to synthesize means to create or to make. See if students can use these explanations to develop a definition for photosynthesis. Make sure water, air, sun, sugar, and oxygen are included in the definition.

8. Have samples of fruit and vegetables handy that students can eat to taste the

Grade Levels: (K-2) 3-4

Subject Areas: Language Arts, Mathematics, Life Science, Environmental Literacy & Sustainability, Dance

Setting: Classroom

Time:
Preparation: One-two hours
Activity: Three 50-minute periods

Vocabulary: Carbohydrate, Carbon dioxide, Chemical potential energy, Chlorophyll, Glucose Greenhouse, Heat, Light, Light energy, Molecule, Oxygen, Photosynthesis, Solar energy, Sun, Synthesis, Thermal energy

Standards Addressed:
CC ELA: L.K.4.A, L.K.5.A&D, L.K-2.6, L.1.4, L.1.5.A-B, L.2.3, L.2.4.A-E, L.2.5.A-B, L.3-4.3, L.3.4.A-D, L.3.5.B, L.4.4.A-B, RI.2-4.3, RI.3.4, RL.4.5, SL.K.1.A, SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2, SL.3.1.A-B&D, SL.3.3&6, SL.4.1.A-D, W.K.2&8, W.2.7

CC Math: MP5, 2.MD.1, 2.MD.2

NGSS: 2-LS2-1
SEP: Planning and Carrying Out Investigations
DCI: LS2.A: Interdependent Relationships in Ecosystems
CCC: Cause and Effect

EL&S: Connect: C1.A.i, C1.B.e
Explore: EX2.A.e, EX2.A.i, EX4.A.e, EX4.A.i

Materials:
- Picture or drawing of an animal such as a rabbit (optional)
- Growing plants that have turned their leaves toward the light (optional)
- Fruits and vegetables
- ***Energy Learning Logs*** and writing implements

Continued next page

- Photographs of magnified leaf cells showing chlorophyll (optional)
- Props and materials for Photosynthesis Promenade (optional)
- Ingredients and equipment for making chocolate cookies (optional)

Related KEEP Activities:

Use “Photosynthesis Promenade” to enhance the KEEP activities “Food Chain Game” and “Energy from Food” (KEEP *Energy Education Activity Guide*) and to help students have a better understanding of how energy is stored in food and is transferred to humans when we eat. Available at keepprogram.org.

sweetness. Show students some plants and explain that plants use the sugar they create and other minerals from the soil to build their body structures (roots, stems, leaves, and fruit).

9. Explain that most plants are green because they contain a chemical called chlorophyll. This chemical helps the plant use the sun’s light to make sugar out of water and air. If one is available, show students a picture of a magnified leaf cell with chlorophyll, or ask a biology teacher to let students look through a microscope at a leaf. You’ll need to use a thin leaf such as one from a water plant or an elodea.

10. Involve students in simulating how water and air particles are recombined into sugar. Younger students can gain insight into the process of how materials are recombined to create something new through the ***Chocolate Chip Demonstration***. Older students can participate in the ***Photosynthesis Promenade.***

11. Have students revisit the food chain they created at the beginning of the lesson. Ask them to explain what is happening between each link, especially between the sun and the plant. Listen to see if they use the term photosynthesis.

Assessment

- Have students revisit the food chain they created at the beginning of the lesson. Ask them to explain what is happening between each link, especially between the sun and the plant. Listen to see if they use the term photosynthesis.
- Ask students to define and describe photosynthesis.
- Have students draw a picture or write a simple story about the role of the sun or the life stages of a plant. Check to see if students describe how the sun helps the plants make food out of carbon dioxide and water. Students can put their stories in their ***Energy Learning Logs*** or add their drawings to the ***Energy Flow Mural***.

Suggested Sun Test Procedure

Ask students how they can prove that a plant will die without sunlight. If they suggest shutting a plant in a dark closet, what other things might the plant not get that could contribute to the plant’s death? Help them to understand that if the plant is not watered or if it does not get air, it will also die. Students need to make sure they are testing for only one item or variable. Encourage students to develop their own test to show that plants need sunlight. Below is one procedure they might follow.

Plant seeds (bean or pea plants are recommended) and grow them to a few inches in height. Then allow one plant (the control) access to sunlight, water, and air. Have another plant get air and water, but no sunlight (put the plant in a dark closet). Let the third plant get sunlight and water, but no air (cover the plant with a plastic bag). Provide the fourth plant with sunlight and air, but no water. Make careful observations in your ***Energy Learning Log*** of what happens to each plant.

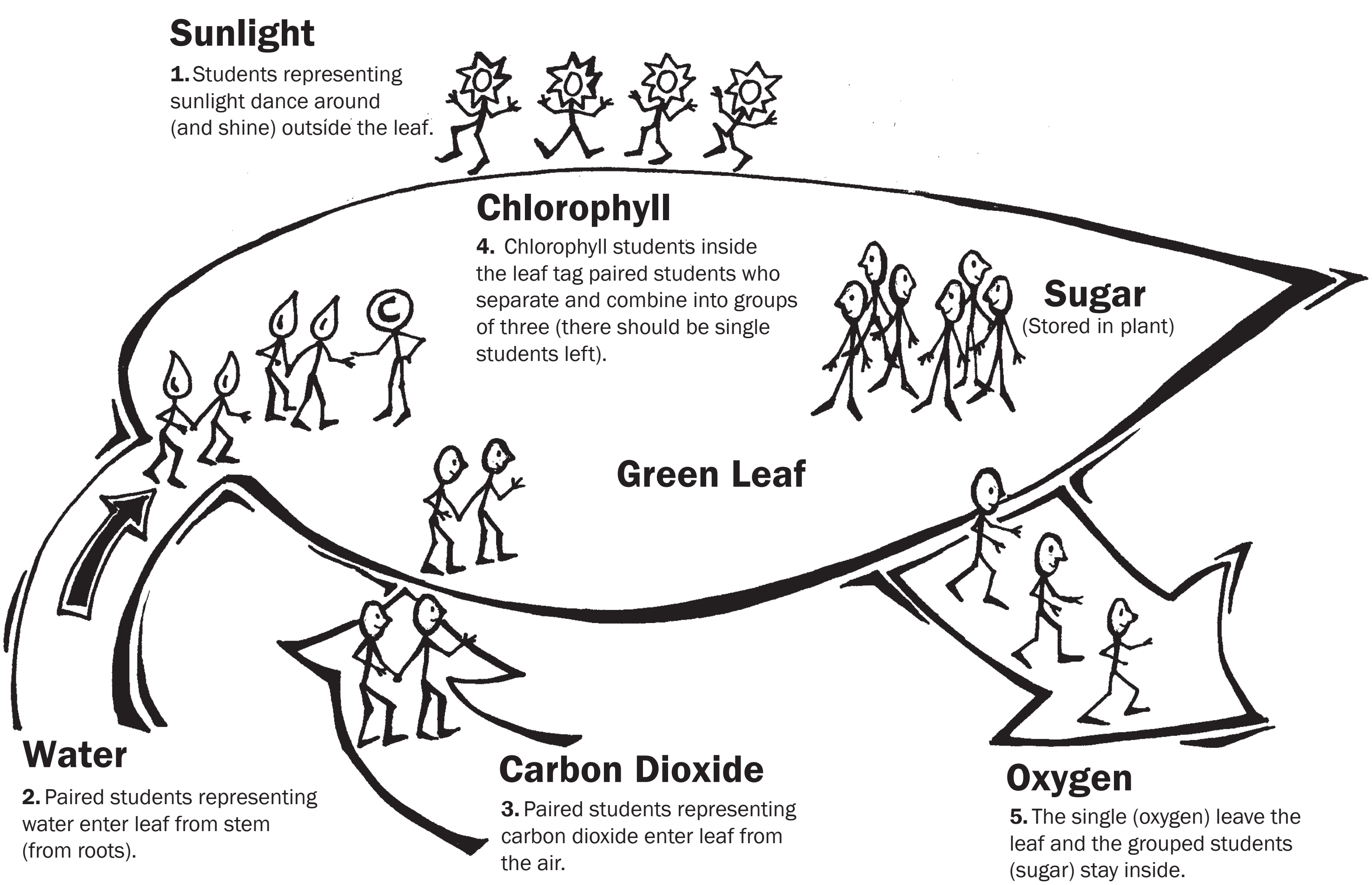
Chocolate Chip Demonstration:

To help students appreciate how air and water are recombined to create sugar, show students a chocolate chip cookie and ask them how they think it is made. Describe how a cookie is prepared from scratch (or involve students in baking cookies). Explain (or show) that the different ingredients such as butter, flour, chips, sugar, water, etc. are combined, but that they do not actually become cookies until thermal energy (heat) is added. This process is much like a plant using sunlight to recombine carbon dioxide and water to make sugar.

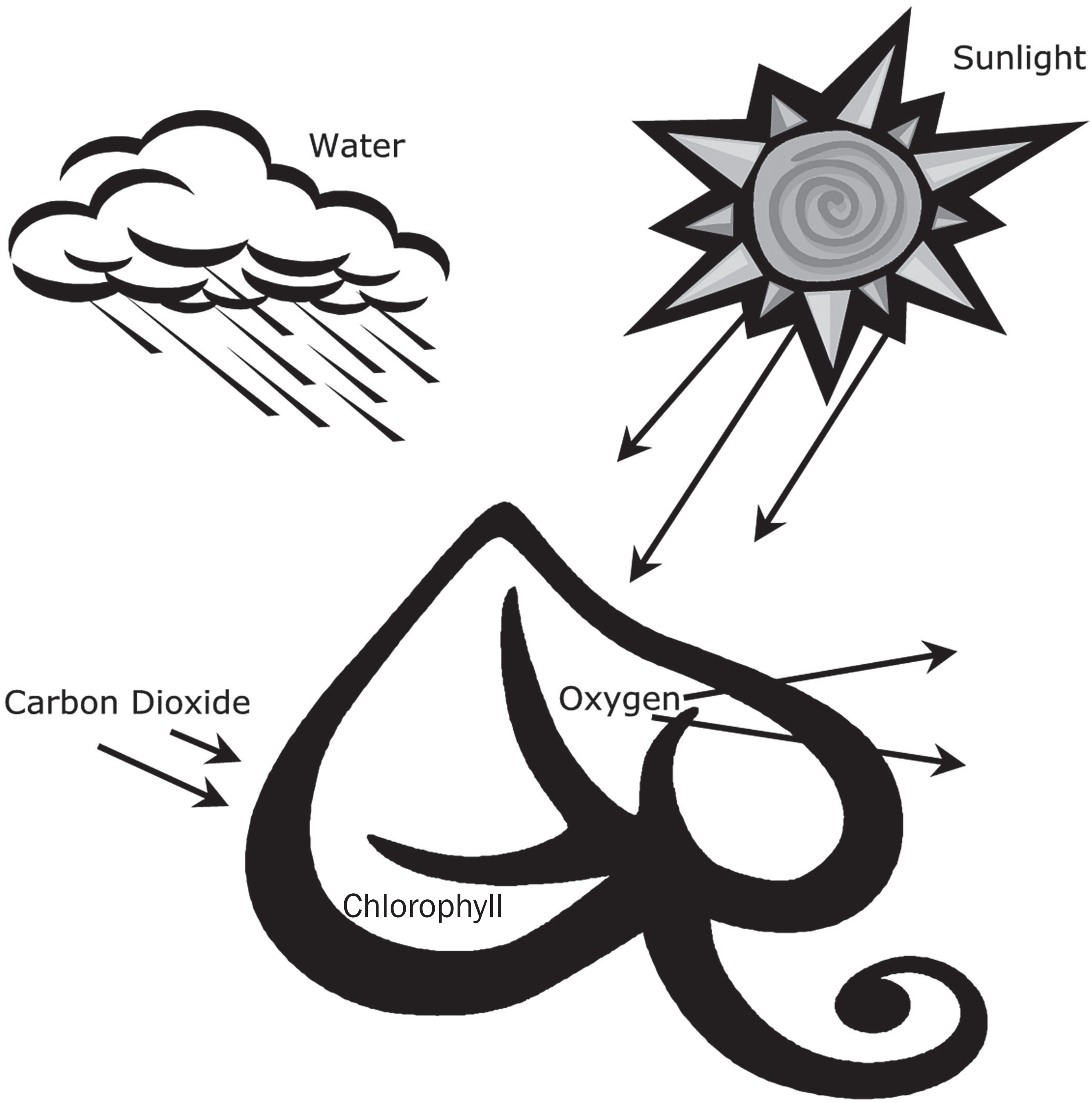
Photosynthesis Promenade

For the promenade, students might be interested in adapting the simulation into a dance or play with costumes and props. For example, students representing chlorophyll can be dressed in green (or use colored name-tags) and those representing the sun can be dressed in yellow and carry flashlights. A simple stage can be created to represent the leaf. Make sure students understand that this is a simple demonstration and does not represent the actual chemical process, which is very complex. If you do the simulation as a dance, consider playing music.

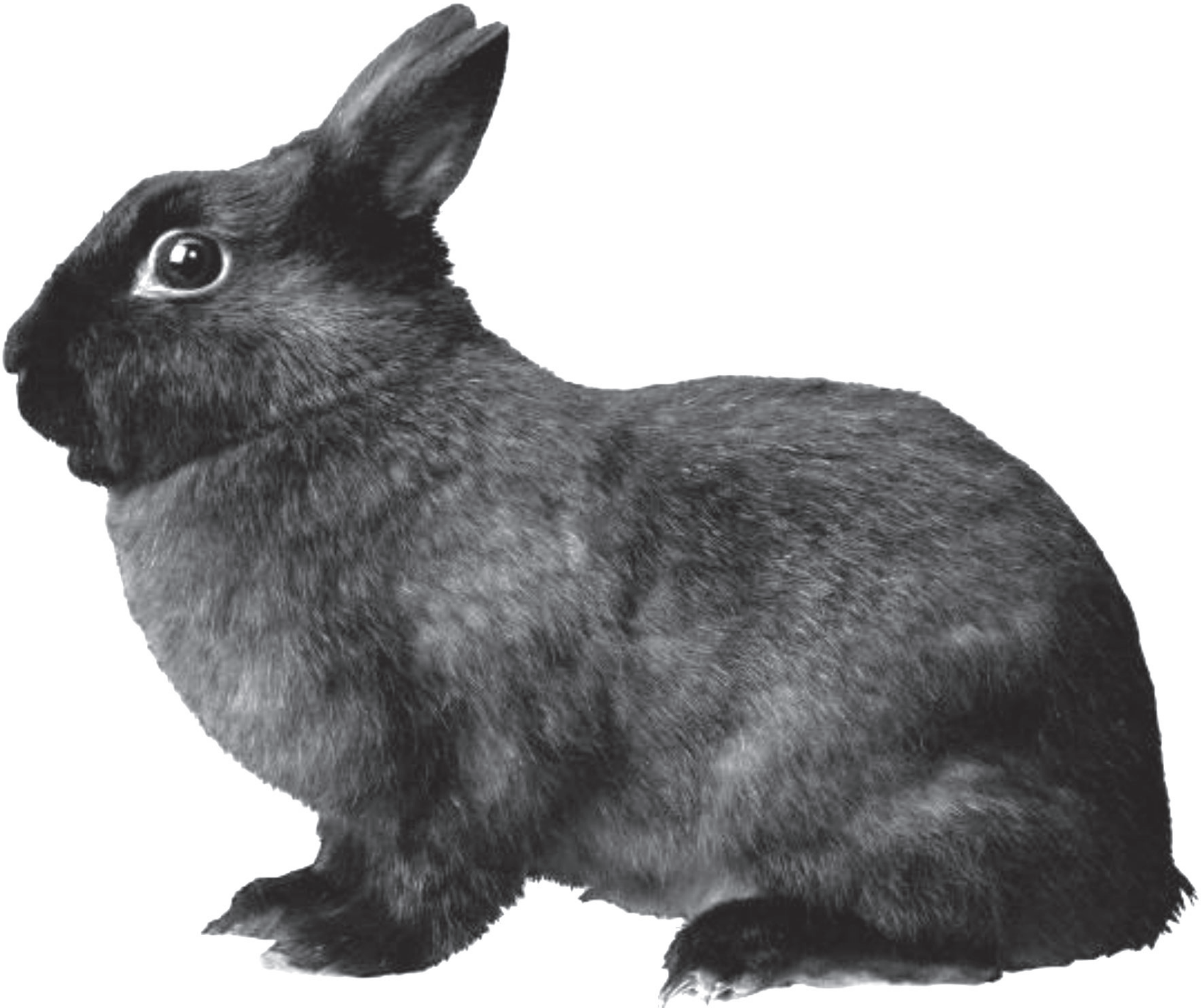
- Designate one section of the room as the leaf of the plant.
- Divide the class in half and have each half stand on either side of the leaf. Instruct students to stand in pairs. Pull out a few extra students to play the sunlight and chlorophyll. Direct the chlorophyll student(s) to stand inside the leaf area.
- Tell half the students they are air particles and the other half they are water that is coming to the leaves from the roots (drawn up from the plant's stem). It might be helpful to give them signs labeling them as water or air molecules (particles).
- Instruct students to file as pairs into the leaf area.
- Provide the students representing sunlight with a flashlight and tell them to stand outside the leaf and shine the light on the students who are chlorophyll. Students should shine the light during the whole next step; they might want to dance about to music while shining the light. (Be sure students so not shine the light in other students' eyes.)
- The chlorophyll students gently tag the air and water pairs once they enter the leaf. When paired students are tagged, they separate. If signs are being used, the chlorophyll students should take these away. When all the students are milling about into singles, instruct the chlorophyll students to recombine students into groups of three; there should be some single students left over.
- Direct the single students to leave the leaf.
- Ask students to suggest what the recombined group and single students are. The groups are sugar molecules and the single students represent the oxygen molecule (which is actually composed as two oxygen atoms). New signs can be distributed to these two groups.»



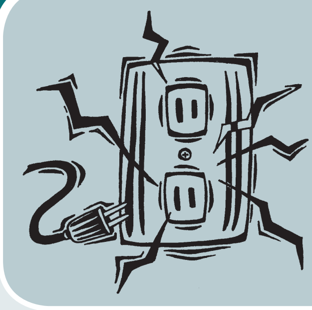
Photosynthesis



Rabbit



Unit 4
Energy from Electricity



Activities

Unit Objective

- Students will be able to illustrate how electricity flows to their school.

Background

In the typical classroom, there are many examples of appliances and devices that use energy. Appliances change energy from one state, or form, to another (e.g., electrical to mechanical, or electrical to light). The energy source for most of these items is electricity. Schools usually get their electricity from a power plant. Power plants use a variety of energy resources to generate electricity, including fossil fuels (coal, oil, and natural gas), nuclear power, and hydropower (water). Each of these resources is used to cause a turbine shaft to rotate. The rotating turbine shaft is connected to a generator containing a large wire coil. As the turbine shaft spins, it causes the generator's wire coil to turn. The spinning wire coil spins around large magnets, creating an electric current. Through this process, the generator converts the mechanical energy of the spinning turbine to electrical energy. The electric current produced by the generator in the power plant is then transmitted through power lines to homes and businesses in the surrounding community.

A simplified definition of an electric current is moving electrons. Electrons move because of the energy provided by a battery, a generator, or a similar source of electricity. Electrons flow through materials, such as copper wire, that will conduct them. Human beings can also conduct electricity, which is why it is extremely important to stay away from power lines and to avoid touching wires that are frayed or damaged. Contact your local utility representative to learn other safety precautions.

When electricity reaches the school (or home or business) through the power lines, wires in the building carry the current through the school. Electrical sockets are ways to connect appliances to the electrical current supplied by the power plant.

Appliances are conversion devices that change energy from one state to another. For example, a light bulb changes electrical energy to light energy. Other appliances have motors that convert electricity to mechanical energy, such as in a blender or a fan. Other signs of energy observed in appliances include sound, light, movement, and heat.

Another major energy user in schools is the heating, ventilation, and cooling system (HVAC). The majority of schools in Wisconsin use furnaces or boilers that burn natural gas, fuel oil, or propane (also called liquid petroleum gas, or LPG). Electric baseboard heat is used in some smaller schools.

Schools use large amounts of energy to light classrooms, run appliances, and maintain comfortable room temperatures. Next to personnel costs, energy expenses are usually a school's largest budget item. If schools spend less on energy, those funds will be available for other items students need.

Teachers and students can help reduce energy costs by turning off lights and appliances when they are not in use and encouraging the school to purchase energy-efficient items. Schools could save close to 30 percent of their energy expenditures through operational changes (such as energy-efficient lighting, insulation, and innovative HVAC systems).

See additional information in the following KEEP activities at keepprogram.org:

- Evidence of Energy
- Station Break
- At Watt Rate?
- Where Does It Get Its Energy?
- Circuit Circus
- Waterwheels, Windmills, and Turbines
- Electric Motors and Generators

Classroom Energy Flow

Summary:
Students create an energy flow diagram of their classroom by labeling and describing how objects in their classroom transfer energy.

Objective

- Students will identify the flow of energy through various objects within their classroom.

Procedure

1. Review as necessary the evidence of energy in students' lives (movement, light, sound, and heat). Make sure students recognize common sources of energy (electricity, batteries, human effort, etc.).

2. Inform the class that they're going to make an energy map of the classroom.

3. Divide the class into small groups. Give each group an ***Energy Flow Arrow.*** Tell students they will be posting the arrows on items in the room that display evidence of energy.

4. Explain that the arrow has three parts. In the middle of the arrow, students will write or draw an item in the room. On the pointed end of the arrow, students should write or draw the evidence of energy the item displays. On the base of the arrow, students should write the source of energy for the item. Tell them to draw a question mark if they do not know the source.

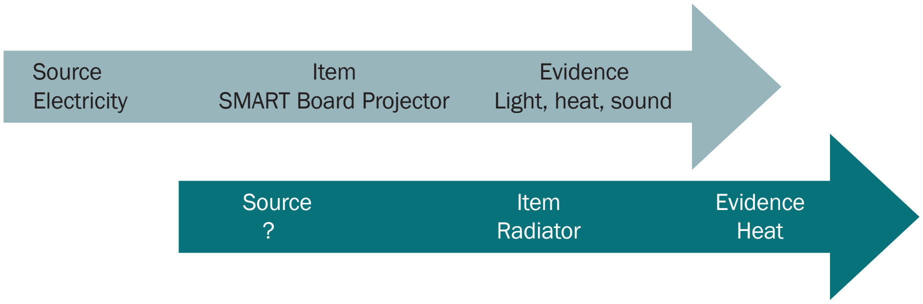
5. Share the following two examples. In the first example, the SMART Board Projector emits light and gets its power from electricity. Students might also notice that the projector gives off heat and sound. Decide if you want to add that to the same arrow or use a separate arrow for each evidence of energy. In the second example, students might know that heat comes from a radiator, but they don't know what the energy source is (indicated by the question mark).

6. Ask each group to identify one item and make an arrow for it. If students have trouble finding items, refer them to the list of ***Common Classroom Energy Items.*** Hand out more arrows as needed until there are arrows over all appropriate energy items. NOTE: An alternative is to make a game out of the activity. For example, one group identifies an item and another group has to identify the energy form or the source or both.

7. After items in the room have been labeled, have the entire class share their labeled items and energy flows for the classroom. Work with students to fill in any blanks or clarify incorrect information. For example, if students do not know the source of heat for the radiator, whom could they contact to find out? They might want to invite the custodian or facility manager to explain or give them a tour of the heating and air conditioning system for the school.

Assessment

- Use the Energy Flow Arrows to quiz students on how items in the room transfer energy by having students fill in blank sections of the arrow; this assessment can be in a game format like in Step 7.
- Have students refer to the arrows to make a map of the room in their ***Energy Learning Logs*** and diagram the classroom energy flows (it might help to draw the map from a bird's-eye view). If the class is making an ***Energy Flow Mural***, have them locate where their electricity or natural gas source comes from and put this information on the mural.



Grade Levels: K-4

Subject Areas: Physical Science, Environmental Literacy & Sustainability

Setting: Classroom

Time:
Preparation: 10 minutes
Activity: Two 50-minute periods

Vocabulary: Energy, Energy source, Heat, Light, Light energy

Standards Addressed:
CC ELA: L.K.4.A, L.K.5.A&D, L.K.6, L.1.4, L.1.5.A-B, L.1.6, L.2.3&6, L.2.4.A-E, L.2.5.A-B, L.3-4.3, L.3.4.A-D, L.3.5.B, L.4.4.A-B, RI.2-3.10, RI.3.3-4, RI.4.3&10, SL.K.1.A, SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, W.2.7, W.K.2&8

NGSS: 4PS3-2
SEP: Planning and Carrying Out Investigations
DCI: PS3.A: Definitions of Energy
CCC: Energy and Matter

EL&S: Explore: EX4.A.i, EX4.B.e
Engage: EN6.A.i, EN6.C.e

Materials:
- Copies of ***Energy Flow Arrows***
- Masking tape
- ***Energy Learning Logs*** and writing implements

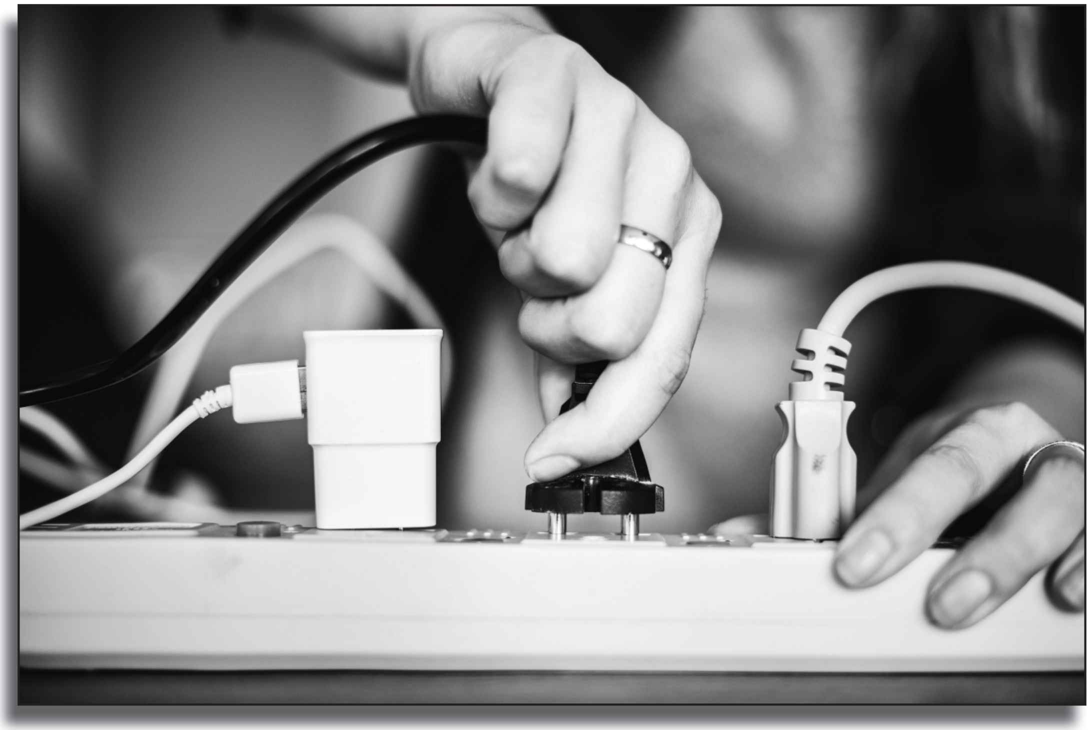
Related KEEP Activities:
Have students participate in KEEP activities "Evidence of Energy" and "Where Does It Get Its Energy?" prior to this activity to help them recognize energy forms and sources. Available at keepprogram.org.

Extension

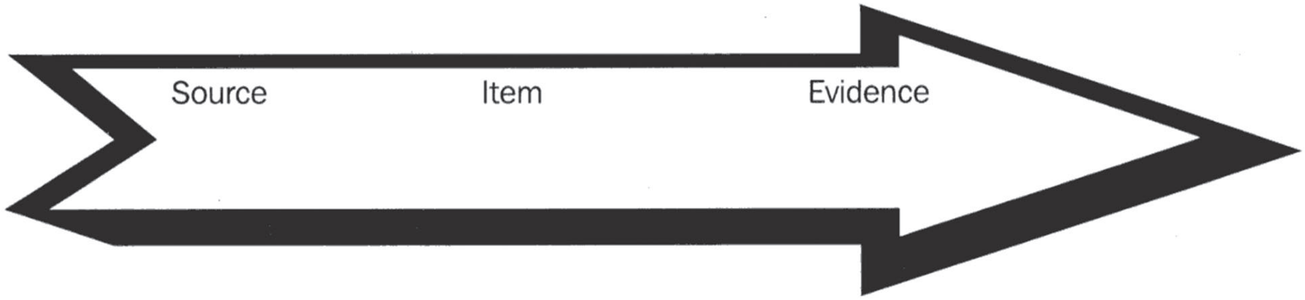
Challenge students to trace the sources of energy further back. For example, they might have identified electricity as powering many items, but do they know where the electricity comes from? This activity would be a great opportunity to invite a representative from the community utility to present about electricity generation and energy resources, such as coal and nuclear. The representative can also share important electrical safety information.

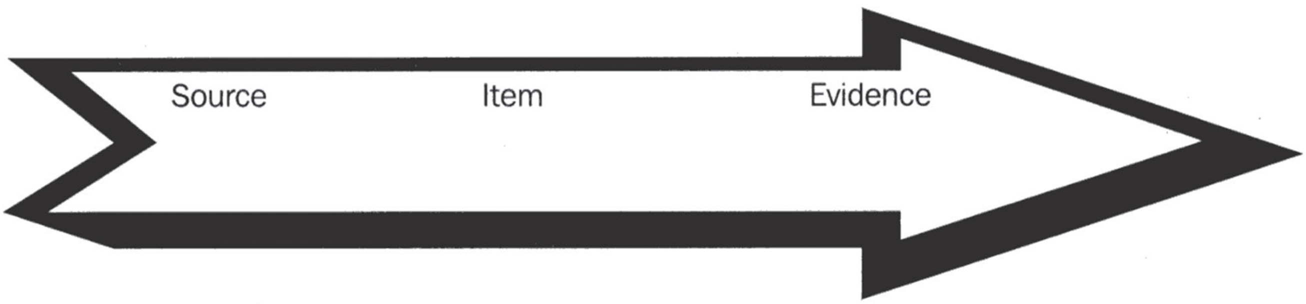
Common Classroom Energy Items

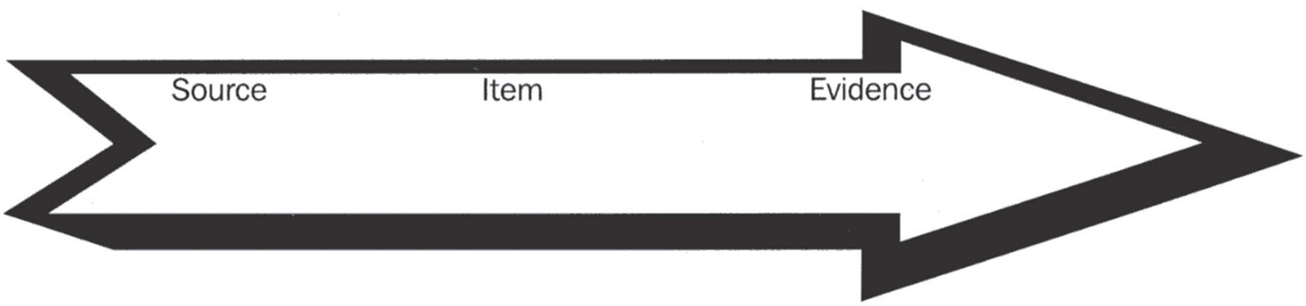
- Lights, appliances
- Radio, television
- Furnace and air conditioner vents
- Gas hookups in science laboratories
- Projector
- Sinks (hot water)
- Computers
- Clocks

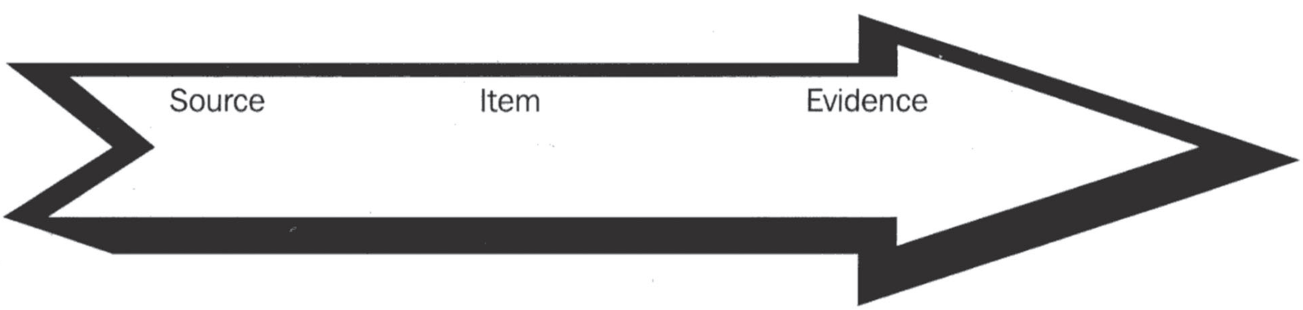


Energy Flow Arrows



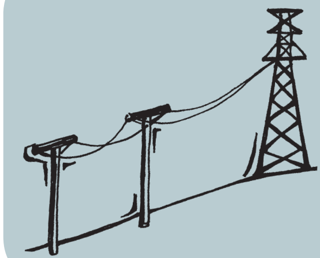






Summary:
Students illustrate through a whole-body demonstration how electricity flows from the power plant to appliances in their classroom.

Electric Charades



Grade Levels: (K-2) 3-4

Subject Areas: Language Arts, Physical Science, Environmental Literacy & Sustainability

Setting: Classroom

Time:
Preparation: 30 minutes
Activity: Two 50-minute periods

Vocabulary: Current, Electric current, Electricity, Electron, Energy

Standards Addressed:
CC ELA: L.3-5.3, L.4-5.4&6, RI.K-5.4, RI.2-4.3, RI.3-4.7, RL.K&3-4.4, SL.K-2.1, SL.K.3, SL.K-1.5-6, SL.3-5.3, W.K.2-3

NGSS: 4-PS3-2
SEP: Planning and Carrying Out Investigations
DCI: PS3.A: Definitions of Energy
CCC: Energy and Matter

EL&S: Connect: C1.A.m, C1.B.i
Explore: EX2.A.e, EX2.A.i, EX2.A.m, EX4.A.i

Materials:
- Props for charades (optional)
- Electrical appliance

Related KEEP Activities:
Prior to this activity have students participate in “Classroom Energy Flow.” The activity “Waterwheels, Windmills, and Turbines” introduces students to electricity generation. Older students can further their understanding with “Circuit Circus” to learn about circuits. NOTE: “Circuit Circus” represents electrical flow from a battery (direct current, or DC), which is different than the type of current received by schools and homes (alternating current or AC). Available at keepprogram.org.

Objective

- Students will be able to describe how electricity flows to items in their school.

Procedure

1. List several items in the classroom such as the SMART board, computers, and the lights. Ask students what these items have in common. See if the students list electricity; if they do not, help them recognize electricity as a common element (for example, ask what you have to do to turn the items on and make sure they are running).

2. Tell students they are going to play a game of charades in which groups of students will act like an electrical item and the class will need to guess what item is being portrayed. Inform students this is a whole-body demonstration in which they will become the appliance or electrical item and should illustrate how it functions or works (evidence of energy). For example, if they are an electric pencil sharpener, three students could hold hands and stand in a circle (representing the sharpener) and turn around a student (representing the pencil) standing in the middle. They should not demonstrate the pencil sharpener by acting out a person putting pencil in a pencil sharpener. Decide if props and sound effects are allowed.

3. Divide the class into groups of three or four. Assign each group an electrical item or have them choose their own (you will need to make sure there are no repeats). See ***Electrical School Equipment*** for a list of ideas. Give each group time to prepare its skit, providing coaching as needed. Make sure each presentation illustrates how the item works.

4. Have each group demonstrate its item and see if the rest of the class can guess what is being portrayed. Encourage the groups to identify the item and the evidence of energy displayed. Award points if desired.

5. When students have completed the skits, plug an appliance into an electric socket and turn it on. Ask them if they know where the electricity to run the appliance (as well as the items portrayed in their skits) comes from. Note their responses.

6. Explain that electricity is generated at the power plant and travels through wires to the school and to the appliances. Refer students to the power lines they see around their school and home and wires that run to their home. Inform them that many wires run underground so they might not see them. This might be a good opportunity to stress electrical safety (see Extensions).

7. Tell students they can add electricity flow to their charade skits. Have one group come to the front of the classroom and demonstrate its electrical item. Have the rest of the class represent a power line running from a power plant to the appliance by standing in a row with one end near the modeled electrical item. Stand or have a student stand at the other end to represent the power plant.

8. Inform students that the power switch for the item has been turned on and that they will symbolize the flow of electricity from the power plant to the school. To show this, the “power plant” taps the first student in the “wire” row who taps the second student, who taps the third, and so on until the last student in the row is tapped. This last student taps one of the students in the modeled electrical item. (Students can also say the word “electricity” during tapping to emphasize energy transfer.) When one of the students in the modeled item is tapped, those students begin to act out their charade. To emphasize energy flow, the power plant should continue tapping until the power switch for the item has been turned off.

9. Have the class review items in their classroom and school that use electricity and where the electricity comes from. Students can repeat the electricity flow for other items and relate the activity to appliances they use at home.

Assessment

- Have students describe how various electrical items in their home display energy use.
- Ask students to diagram how electricity flows to electrical items from a power plant.
- Ask students to diagram in their ***Energy Learning Logs*** how electricity flows to electrical items from a power plant.

Extensions

Adapt the activity into a version of the game Red Light/Green Light. One student plays the on/off switch. When her back is turned the electric current flows, and it stops when she turns around. The students demonstrating the electric flow should try to anticipate when the switch will be turned on and off (when she turns toward and away from them) and not be spotted moving.

Help students understand that the flow of electricity continues whenever an item is left on. Repeat the skit using an electrical item with the row of students lined up (explained above). Have one student act as if he turned the item on and left the room. What does the current do? Students might know that their parents have to pay an electricity bill. Essentially, they are paying for this flow of electrons to pass through their home. So more electrons are transferred the longer an item is left on, which results in a more expensive bill. Discuss simple ways students can reduce their energy use (specifically, turning items off when they are not in use). Students can create stickers to post on or near electrical items such as light switches reminding people to turn off items when not in use.

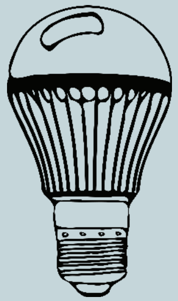
Involve students in a scavenger hunt to look for appliances that have the ENERGY STAR® label on them. Explain that this symbol represents items that use energy efficiently so we need less electricity and can save money. Take students on a tour of an appliance store or ask an energy consultant to explain the advantage of ENERGY STAR-labeled items.

Invite someone from the local utility to speak about electrical safety. Inform students that electricity will flow through other items besides wires, including water and human bodies! Tell students that they can be harmed or killed if they touch a wire that is broken or frayed, because the electricity might be transferred through them.

Electrical School Equipment

- Computer
- SMART Board projector
- Ipad
- Photocopier
- Printer
- Radio
- Television
- DVD player

Appendix



Energy Ideas

Gaining Understanding of Students' Thoughts about Energy

Objectives

Students will be able to:

- express and analyze ideas about energy and
- discriminate among scientific and common definitions of energy.

Rationale

Energy education is often equated with activities that involve young students in measuring their energy use or conducting energy audits. While students may enjoy monitoring their school or home to find cases where energy is being used unnecessarily, it is important that students understand the reasons for these monitoring activities. Without proper understanding of energy resources, energy degradations, and energy conservation, students might consider the activity simply a game and not see the reason to continue these actions after the lesson is completed.

What should elementary school teachers do when trying to teach students about energy? Although it is unrealistic to expect young children to grasp complex and abstract conceptions of energy, they can begin to investigate various definitions of energy and analyze what energy means to them. If they share these thoughts and ideas with their teachers, lessons can be designed to strengthen correct understandings of energy and to help children recognize limitations in incorrect definitions. The following strategy is one approach to help elicit students' thoughts about energy and give them the opportunity to analyze their ideas.

Introduction

- You sure have a lot of energy!
- Energy is getting expensive!
- I think my battery has run out of energy.
- It will take a lot of energy to move that rock.

These are all common uses of the term energy, but in strict scientific terms they are not exactly correct (see ***True or False?*** for explanations of why some common uses of the term energy are scientifically incorrect). Given that the word is used so often and in so many different ways, it is no wonder that students may have misconceptions about what energy is. Secondary science teachers sometimes struggle with trying to get students to overcome misunderstandings of energy.

Elementary teachers can help prepare students to appreciate what energy is by encouraging them to become aware of the presence of energy in their lives. By participating in activities in the KEEP *Energy Education Activity Guide* and this supplement, students receive a well-rounded introduction to basic energy concepts and begin to appreciate the energy in their lives.

To better prepare students for their energy education, it would be helpful for teachers to know students' current thoughts and ideas about energy. This activity suggests a procedure for providing students with the opportunity to share their ideas about energy and explore how they apply energy to various aspects of their lives and within science class. While listening to students explain phenomena they observe, teachers can assess if and how students use energy and energy-related terms.

It might be too early to introduce abstract concepts such as energy conservation, but it will be helpful to teachers to know if students equate energy with terms such as effort, force, motion, or fuel. Subsequent lessons could further help students distinguish between these terms and understand how they are used in science. These lessons would help students construct foundational knowledge about energy that would support more scientific energy conceptions later in their learning career.

On the next page is a brief overview of some basic energy concepts. Additional explanations of energy are found throughout the activities and the ***KEEP Adaptations*** in this supplement, and in the KEEP *Energy Education Activity Guide*.

Procedure

Designate a bulletin board or a section of your classroom wall to post "Energy Ideas." Here students write sentences that depict what they think energy is. Students can generate ideas in one classroom lesson or you might want to give them a week to post ideas as they think of them. Make sure students know that any idea is a good one; for now they are to generate as many ideas as possible. NOTE: have preliterate students draw pictures and dictate their thoughts to be transcribed.

After students have posted a number of ideas, give students a chance to read through or look at all the ideas. See if students think any ideas are similar and should be grouped together. Try to narrow the number of ideas to five or less.

Have students generate a one-sentence description for each idea. Ask students to examine each idea to be sure it makes sense to them.

Option: You might want to narrow the ideas down even further. Have students decide whether they agree or disagree that each idea defines energy. Encourage students to express the reasoning behind their opinion. This discussion could continue over several days or weeks, supplemented by activities to explore each idea. Over time, students might change their opinions or generate new ideas. Some of the ideas will be more scientifically accurate than others. Challenge students to categorize their thoughts about energy into "scientific" explanations compared to common everyday expressions.

Option: Invite a physical science teacher in to examine the ideas. She or he might identify true meanings behind some of the ideas. For example, the sentence: "It takes a lot of energy to move a boulder" would be more correctly stated, "It takes a lot of work to move a boulder." The teacher might also be able to identify supplementary activities to help students examine their ideas more extensively.

Divide the class into groups of three or four. Have each group design a poster or a skit to portray their understanding of energy. You might want to work with the art teacher to identify creative ways for students to illustrate their posters.

Assessment

- During the activity, observe student contribution and analysis of ideas.
- Examine students' posters to see if they reflect the ideas generated during class.
- Ask students to provide a definition of energy and notice if they provide a rationale for their description.

Energy Basics

A common definition of energy is the ability to do work (or to organize or change matter). Work involves force and motion. You can see evidence of energy when something moves or changes (when work is done). Light, thermal energy, and sound are other ways we can detect energy. People might think of energy as a substance such as fuel or a force or power, but in scientific terms energy is a state or condition that can be quantified and measured.

Scientists use energy to describe certain properties of an object or a series of objects. It is similar to how you can describe an object's weight or size, and you can assign a value to quantify an object's energy.

Energy is transferred from one object to another during work (when there is movement or change). The amount of energy that is present before and after work is the same (scientists say energy is conserved). For example, let's say you drop a ball. Scientists can measure the energy before, during, and after the fall. The amount of energy remains constant throughout the process—it is just in different states. Likewise, when an object is thrown, a spring released, or something burned, the energy can be measured and will remain constant. This is the reason behind the statement, "Energy can neither be created nor destroyed, it can only be converted from one form to another." Scientists have found that the amount of energy in a closed system remains constant.

Wherever you look, you can see examples of energy transfers. When you turn on a light, you see the result of energy being transferred from the sun to the plants to the coal to electricity and finally to the light you see. During each of these transfers, energy changes form. There are two main forms of energy—kinetic energy (motion) and potential energy (position). To further classify energy, these forms are sometimes described as thermal (heat), elastic, electromagnetic (light, electrical, magnetic), gravitational, chemical (food), and nuclear energy. See the KEEP *Energy Education Activity Guide* for more information on kinetic and potential energy.

During energy transfers, it might seem that energy does go away or become reduced. For example, a bouncing ball stops bouncing, a battery dies, or a car runs out of fuel. The energy still exists but it has become so spread out that it is essentially unavailable. Burning a piece of wood releases light and thermal energy (commonly called heat). The light and heat become dispersed and less useful. Another way to describe this process is to say the energy is concentrated in the wood (chemical energy) and becomes less concentrated in the forms of thermal and light energy.

Energy has often been called the currency of life. It flows through Earth's processes, creating wind, providing light, and enabling plants to create food from water and air (carbon dioxide). Humans have tapped into this flow to generate electricity, fuel our cars, and heat our homes. The sun provides Earth with most of its energy. It is important for students to recognize and appreciate this source of energy and to explore the transformations that bring the sun's light into their home in the form of light, heat, food, and fuel. We are fortunate to have many "concentrated" sources of energy. Besides the sun, there is chemical energy found in fossil fuels such as coal and oil and in nuclear resources.

While the amount of energy in our world remains constant, as we use it (transfer it to one form to another), it becomes spread out and less useful. Energy also gives us the ability to work. Through education and becoming aware of what energy is and how we use it, we can learn (i.e., work) to use our concentrated resources more wisely and ensure that they will be available for future generations.

True or False?

- **Energy is found only in living objects.**
- **Energy is a force.**
- **Energy is associated only with movement.**
- **Energy is all that is needed to cause things to happen.**
- **Energy is a fuel.**
- **Energy is a substance or fluid.**
- **Energy is created as the result of an activity.**

In strict scientific views, all these statements are false. Following are explanations of why these energy descriptions are "wrong":

- **Energy is found only in living objects.**
  This statement is not correct because everything has energy. The composition of an object or its placement determines what kind of energy it has (e.g., chemical, thermal, gravitational). Living things are unique in that they have the natural capacity to convert energy to another form from the food they consume.

- **Energy is a force.**
  A force is a push or a pull. Energy is needed to create the force, but it is not the force. A force, through movement, changes the state of energy in an object (e.g., from potential to kinetic energy).

- **Energy is associated only with movement.**
  Non-moving objects have potential energy (sometimes called stored energy).

- **Energy is all that is needed to cause things to happen.**
  It is acceptable to say energy is needed to lift an object or move things, but other conditions (such as force) are needed as well.

- **Energy is a fuel.**
  Fuel is a source of energy, but the fuel itself is not energy. Fuel is a resource, such as oil, coal, or foods that we eat. Fuel sources have potential energy in the chemical bonds that make up the substance.

- **Energy is a substance or fluid.**
  Energy exists as a state of matter. However, it is not matter itself (i.e., it does not have atomic or molecular structure, nor does it react or combine chemically with other types of matter). For example, steam, liquid water, and ice are all made of water molecules, but appear different because they each exhibit different states of energy.

- **Energy is created as the result of an activity.**
  Energy is transferred from one system to another as the result of an activity or process, such as generating electricity or eating food. However, no additional energy is ever created during an activity. Were this to be so, then energy could be created from nothing—which is not possible.

KEEP Adaptations

Refining or Adjusting KEEP Activities and Sparks to Support Energy Understandings

Simple Machines

The main understanding for students to achieve during a simple machines lesson is that the tools change the direction of a force. Machines change the state of energy to produce work. Work is force times distance. Another way of saying this is that humans use their energy with simple machines to do work by changing the state of energy of the object (system) they're working on (e.g., from potential to kinetic).

The result of simple machines is that the same amount of energy is transferred (used), but because the effort is less students often mistakenly think less energy is used. Machines make the effort easier for humans, but the same amount of work is done. Simple machines also make work easier because they use less power (i.e., they are faster and require less time; they increase the speed at which the work is done). Students might have heard the term "powerful" used with certain automobiles. The car is powerful because the engine allows the car to increase from 0 to 60 mph in less time.

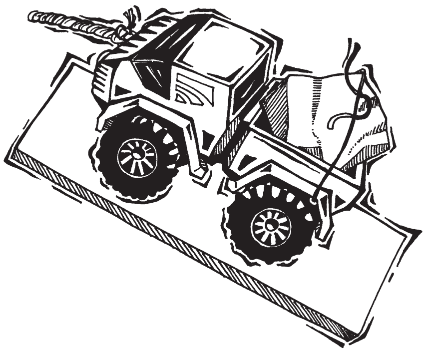
It might be too difficult to introduce the role of energy in the simple machines lesson; however, the following challenge could help students consider energy transfer when examining how simple machines "work." The main objective of this exercise is to help students who equate energy with effort or with force. This activity can help these students begin to understand that saying the amount of energy varies with machines is not a scientifically accurate use of the term energy. Of course, in everyday language, these applications are acceptable.

Challenge Question:

A person is directed to put a heavy box that is on rollers onto the back of a truck. She can lift the box to the truck, use a steep ramp, or a ramp that is less steep.

Ask students:

- Which simple machine does the ramp represent? (The lever)
- Which method they would choose and why? (Notice if they use the term energy in their answers.)
- Which method gets the most work done? (This question is a tricky one; the work is essentially the same: work = force x distance. Because of friction force, there would be some minimal difference among the methods.)
- Which method uses the most energy? (This is another tricky question. With any of the methods the box ends up at the same height, so whatever amount of energy is transferred is essentially the same. The individual might need to use more effort to lift, pull, or push the box with the steeper ramp or with no ramp, but the energy transferred to the box is the same no matter which method is employed.)



Energy Forms

Within the KEEP Energy *Education Activity Guide* as well as in other energy education resource materials there are lessons that help students explore energy forms. In strict scientific terms, there are only two forms of energy: potential and kinetic. More specific forms of energy include thermal, elastic, electromagnet (light, electricity, magnetic), sound, gravitational, chemical, and nuclear. However, it is important for younger students to recognize the evidence of energy in their lives rather than to worry about whether something is a true form of energy.

The KEEP activity "Evidence of Energy" provides an overview of the presence of energy transfers in students' lives. "Taking Temperatures" and "Exploring Heat" provide a variety of ideas to help students understand heat energy transfers.

Following are some objectives for student learning about motion, sound, and light. The Energy Sparks identify a variety of ideas to help students explore these "forms" more extensively.

Motion
Students will be able to:

- Identify objects in motion around them
- Discriminate between fast- and slow-moving objects
- Compare how various objects move (walk, roll, jump, etc.)
- Analyze whether still objects are really moving (e.g., a plant)
- Investigate what makes objects move
- Explain how muscles enable human movement

Sound
Students will be able to:

- Associate sound with vibration (observe how vibrating objects produce sound and how sound causes objects to vibrate)
- Compare how sound travels through different objects
- Contrast the sounds made by different objects
- Demonstrate how sound travels (via vibration) through solids, liquids, and gases (air)
- Diagram how the vocal cords produce sound
- Explain how the ears transmit sound (through the ear canal to nerve cells so the brain can interpret the sounds)
- Create instruments that generate different types of sound

KEEP Adaptations Continued

Light
Students will be able to:
- Identify sources of light
- Examine how light reflects off different objects
- Discriminate among transparent, translucent, and opaque materials
- List the colors of the rainbow
- Compare how different colors absorb light (radiation)
- Diagram parts of the eye and explain how it transmits light (to nerve cells to the brain so it can interpret what you see)

Other Teaching Ideas
- Read students a story and have them tally the number of times motion, light, sound, or heat is mentioned.
- Have students create a weather station where they record temperature, windiness, and amount of sunshine.
- Students can keep a Sound Log where they notice noises common and unique to each day.

Station Break Down

The KEEP activity "Station Break" provides students with a number of mini-activities to explore different types of energy conversions. For younger students, take one of the stations and expand it into a more extensive unit where students further explore types of conversions.

For example, the station titled Toyland has students investigate wind-up toys. Allow students to look at a variety of toys in more detail. They can take them apart, with supervision, to see how they operate. A number of popular toys move when a child pushes a button that pushes a spring. Challenge students to explore how energy is transferred from them to the toy and how the toy then moves.

Elementary Energy Use Then and Now

The KEEP activity "Energy Use Then and Now" can easily be adapted for younger students. Encourage students to survey or interview their parents and grandparents about how they heated their homes, cooked food, or got around town in their day. Work with students to think of creative ways to share their information with each other or other classes. Students might enjoy acting in a play where they pretend they're pioneers traveling across country and homesteading. Other students can create a picture book titled "Then and Now" where they draw comparative illustrations of how activities took place in the past and the present. Involve students in a matching game where they make connections between past and current appliances (e.g., what would be the match to a mangle? NOTE: See the KEEP activity "Energy Use Then and Now" for information about what a mangle is). Some appliances might not have a match.

Conservation Consternation

The need to conserve energy resources might be a difficult concept for students to grasp. Stories can help students relate this concept to their lives. For example, Aesop's fable "The Grasshopper and the Ant" contains important messages related to saving resources. Read the story to students (or have them participate in a role-play) and ask reasons why saving resources is important. Other stories, such as "The Wump World," "The Lorax," and "Milo and the Magical Stone" can be used to help students make mental connections between the abstract need to conserve resources and implications if resources are not used wisely.

Cross Reference Charts

Grade Level Emphasis

Activity	K–4	3–4
What the Sun Does for Me	X	
Let the Sun Shine Through	X	
Shadows in the Schoolyard	X	
What the Wind Does for Me	X	
Schoolyard Breezes		X
Mapping Wind in the Classroom		X
The "Sun"wich	X	
Detecting Schoolyard Food Chains		X
Photosynthesis Promenade		X
Classroom Energy Flow	X	
Electric Charades		X

Subject Areas

Arts: Art, Dance, Drama and Music
Eng: English and Language Arts
Living: Family and Consumer Education and Agriculture
Math: Mathematics
Science: Environmental, Life, Earth, and Physical Sciences
Soc St: Geography, History, Global Studies, Economics and Government
EL & S: Environmental Literacy and Sustainability

Activity	Arts	Eng	Living	Math	Science	Soc St	EL & S
What the Sun Does for Me	x	x	x	x	x		x
Let the Sun Shine Through	x	x		x	x		x
Shadows in the Schoolyard		x		x	x		x
What the Wind Does for Me	x	x			x		x
Schoolyard Breezes	x	x		x	x	x	x
Mapping Wind in the Classroom	x	x	x	x	x		x
The "Sun"wich		x	x	x	x		x
Detecting Schoolyard Food Chains		x			x		x
Photosynthesis Promenade	x	x		x	x		x
Classroom Energy Flow					x		x
Electric Charades		x			x		x

Cross Reference Charts

Conceptual Framework for the KEEP Elementary Education Supplement

KEEP's *A Conceptual Guide to K-12 Energy Education in Wisconsin* was designed to direct the development of the *Energy Education Activity Guide*. Below is an abbreviated version of the framework; the chart on the next page shows how the activities address the concepts identified in the framework.

Theme I: We Need Energy

Definition of Energy

- Energy is the ability to organize or change matter
- Energy exists in two main forms (kinetic and potential)
- Energy can be measured and quantified
- Power is the rate at which energy is used

Natural Laws That Govern Energy

- Energy can be transferred from one location to another
- Energy can be neither created nor destroyed; it can only be converted from one form to another (first law of thermodynamics)
- With each conversion, some energy becomes unavailable for further use (second law of thermodynamics)

Energy Flow in Systems

- Energy flows through systems; all systems obey the natural laws that govern energy

Energy Flow in Nonliving Systems

- Energy flows through a variety of nonliving systems

Energy Flow in Living Systems

- Living systems use energy to grow, change, maintain health, move, and reproduce

Energy Flow in Ecosystems, Including Human Societies

- Ecosystems use energy to maintain biogeochemical cycles; patterns of energy flow characterize ecosystems; Wisconsin has five main biological communities: northern forest, southern forest, prairies, oak savannah, and aquatic
- Human societies, like natural ecosystems, need energy to organize and maintain themselves
- Human societies range from hunter-gatherer to industrial depending on how they use energy; Wisconsin and the rest of the United States is an industrial, technologically advanced, high-energy-use society

Theme II: Developing Energy Resources

Development of Energy Resources

- Primary energy sources are those either found or stored in nature; the sun is Earth's principle energy source
- Secondary energy sources are produced from primary energy sources using technology (e.g., electricity generation)
- Energy sources are considered to be resources by individuals and society when they serve societal needs and wants
- The ways human societies have obtained energy resources have evolved over time
- Some energy sources are concentrated and others are diffuse; geographically Earth's energy sources are unevenly distributed
- Certain energy resources are renewable because they can be replaced by natural processes quickly; other energy resources are nonrenewable because they either are replaced very slowly or are not replaced
- Wisconsin imports most of the energy resources it uses (nuclear and fossil fuels); other resources used in Wisconsin include biomass, hydropower, solar energy, and wind, all of which are renewable and can be found within the state

Consumption of Energy Resources

- Supply and demand influence energy resource development and use; global demand for resources is increasing

Theme III: Effects of Energy Resource Development

Quality of Life

- Energy use has affected the quality of human life, including our lifestyles, health and safety, economy, sociopolitical structure, and culture

Quality of the Environment

- Energy use has affected the quality of the environment, which in turn affects the health of organisms living in the environment

Theme IV: Managing Energy Resource Use

Management of Energy Resource Use

- Energy resource management involves societies deciding which resource to use and determining how to use resources efficiently; Wisconsin has a variety of energy conservation programs available
- Citizens can make decisions and take actions that determine how the energy they use will be managed; these decisions and actions are influenced by barriers and incentives

Future Outlooks for the Development and Use of Energy Resources

- New energy resources, new ways of managing energy resources, and new technologies will be developed in the future
- Energy resource management will affect the quality of life and the environment in the future

Cross Reference Charts

Conceptual Framework Cross Reference Chart

Activity	Definition of Energy	Natural Laws	Energy Flow in Systems	Energy Flow in Nonliving Systems	Energy Flow in Living Systems	Energy Flow in Ecosystems	Development of Resources	Consumption of Resources	Quality of Life	Quality of Environment	Management of Energy Resources	Future Outlooks
What the Sun Does for Me	X		X	X					X			
Let the Sun Shine Through	X		X	X								
Shadows in the Schoolyard	X		X									
What the Wind Does for Me	X		X	X					X			
Schoolyard Breezes	X		X	X			X					
Mapping Wind in the Classroom	X		X	X				X	X	X		
The "Sun"wich	X	X	X		X	X		X				
Detecting Schoolyard Food Chains	X	X	X		X	X						
Photosynthesis Promenade	X	X	X	X	X							
Classroom Energy Flow	X	X	X	X				X	X			
Electric Charades	X	X	X	X			X	X			X	
Energy Ideas	X	X	X	X								
KEEP Adaptations	X	X	X	X	X	X	X	X	X	X	X	X

Cross Reference Charts

Cognitive and Process Skills

Coop: Collaboration/Cooperation Skills, including sharing, team work, leading, contributing, aiding, attempting, considering, guiding and supporting

Motor: Psychomotor Skills, including manipulating materials, cutting, folding, mixing, drawing, building, constructing, running, dancing, sensing, locating, and assembling

Comm: Communication Skills, including interviewing, demonstrating, reporting, persuading, debating, describing, public speaking, drawing, listening, discussing, computing, and performing

Recall: Recalling Information, including recalling, repeating, telling, and listing

Interp: Interpreting Information, including inferring, sequencing, paraphrasing, translating, rewriting, summarizing, generalizing, sequencing, classifying, sorting, charting, categorizing, matching, omitting, isolating, and selecting

Appl: Applying Information, including demonstrating, operating, solving, preparing, applying, relating, and showing

Anal: Analyzing Information, including inquiry, identifying cause and effect, identifying components and relationships between components, identifying patterns, and comparing and contrasting

Synth: Synthesizing Information, including predicting, hypothesizing, proposing solutions, problem solving, decision making, drawing conclusions, deducing, inducing, inferring, developing and implementing investigations and action plans, inventing, and composing

Eval: Evaluating Information, including establishing criteria, verifying, testing, assessing, critiquing results, and defending

Activity	Coop	Motor	Comm	Recall	Interp	Appl	Anal	Synth	Eval
What the Sun Does for Me		X	X	X					
Let the Sun Shine Through	X	X	X	X	X		X		
Shadows in the Schoolyard	X	X	X	X	X		X		
What the Wind Does for Me	X	X	X	X					
Schoolyard Breezes	X	X	X	X	X	X	X	X	
Mapping Wind in the Classroom	X	X	X	X	X	X	X	X	
The "Sun"wich	X		X						
Detecting Schoolyard Food Chains	X		X	X	X	X	X	X	
Photosynthesis Promenade	X	X		X	X				
Classroom Energy Flow	X			X		X	X	X	
Electric Charades	X	X	X		X		X	X	X
Energy Ideas			X	X	X	X	X	X	X
KEEP Adaptations		X	X	X	X	X	X		

Common Core Standards for English Language Arts

Activity	Reading Standards for Literature K-5 (RL)	Reading Standards for Informational Text K-5 (RI)	Writing Standards K-5 (W)	Speaking and Listening Standards K-5 (SL)	Language Standards K-5 (L)
What the Sun Does for Me		RI.3.4	W.K.2&8, W.1-4.8, W.3.1.A	SL.K.1.A, SL.K.3-4&6, SL.1.1.B-C, SL.1.4-5, SL.2.1.B-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D	L.K.2.6, L.1.5.B, L.1.6, L.2.6
Let the Sun Shine Through		RI.3.4, RI.4.7	W.K.2&8, W.K-4.7	SL.K.1.A, SL.K.2-4, SL.K.6, SL.1.1.B-C, SL.1.4, SL.2.1.B-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D	L.K.5.D, L.K-2.6, L.1.5.B, L.2.5.A-B, L.3.5.B
Shadows in the Schoolyard	RL.K.1&10	RI.K.1&3&10, RI.1.3&5, RI.2.5, RI.3.3-5	W.K.1-3&8, W.1.1-3&8, W.2.1&3&8, W.3.1.B&D, W.3.7, W.4.1.B-C, W.4.2.D-E, W.4.3.D-E, W.4.7	SL.K.1-6, SL.K.1.A, SL.1.1-6, SL.1.1.B-C, SL.2.1-2, SL.2.1.A-C, SL.2.4, SL.2.6, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D, SL.4.5	L.K.1.A&D, L.K.2.A, L.K.4, L.K.5.A, L.1.1.A&G-H, L.1.2.A-B&D-E, L.1.5.A-B, L.K-1.6, L.2.1-3&6, L.3.1-2, L.3.2.E-F, L.4.1, L.4.1F, L.4.2.D, L.4.3.A-B
What the Wind Does for Me	RL.4.1	RI.2-4.3, RI.3.4, RI.2-4.10	W.K.2&8, W.1-4.2, W.2.7, W.3-4.1.A	SL.K.1.A, SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2&5, SL.3.1.A-B&D, SL.3.5-6, SL.4.1.A-D	L.K.5.D, L.K.6, L.1.5.B, L.1.6, L.2.3, L.2.5.A-B, L.2.6, L.3.3, L.3.5.B, L.4.3
Schoolyard Breezes		RI.3.3-4	W.K.2&7-8, W.1.2, W.2-4.7, W.4.2.D	SL.K.1&3-6, SL.1.1.B, SL.1.3-6, SL.2.1.A-C, SL.2.2&4&6, SL.3.1.D, SL.3.6, SL.4.1.C-D, SL.4.5	L.K.1.D
Mapping Wind in the Classroom		RI.2.3&10, RI.3.3-4&10, RI.4.3&10	W.K.2&8	SL.K.1.A, SL.K.3-4&6, SL.1-2.1.B-C, SL.2.2, SL.3.1.A-D, SL.3.6, SL.4.1.A-D	L.K-2.6, L.1.5.B
The “Sun”wich		RI.3.3-4	W.K.2&8, W.4.2.D	SL.K.1&3-4&6, SL.1.1.B, SL.1.3-4, SL.2.1.B-C, SL.2.2, SL.3.1.D, SL.3.6, SL.4.1.C-D	L.K.1.D&F, L.K.2&4-5.A, L.1.1&5.A, L.1.2.B, L.3.1.I, L.3.2, L.3.4.D, L.4.1.F
Detecting Schoolyard Food Chains	RL.K.1&10	RI.K.1&3&7&10, RI.1.3&6, RI.3.4&7	W.K.1-3&7-8, W.1.1&3&7-8, W.2.1&3&7-8, W.3.1.B&D, W.3.7, W.4.1.B-C, W.4.2.E, W.4.3.D&E, W.4.7	SL.K.1.A, SL.K.2-6, SL.1.1.A-C, SL.1.2, SL.1.4-5, SL.2.1.A-C, SL.2.2, SL.2.6, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D	L.K.1.A&D, L.K.2.A, L.K.4&6, L.K.5.D, L.1.1.A&G-H, L.1.2.A-B&D-E, L.1.5.B, L.1.6, L.2.1-3, L.2.5.A-B, L.2.6, L.3.1, L.3.2.E-F, L.3.3, L.3.5.B, L.3.6, L.4.1.F, L.4.2.D, L.4.3.A-B, L.4.6
Photosynthesis Promenade	RL.4.5	RI.2-4.3, RI.3.4	W.K.2&8, W.2.7	SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2, SL.3.1.A-B&D, SL.3.3&6, SL.4.1.A-D	L.K.4.A, L.K.5.A&D, L.K-2.6, L.1.4, L.1.5.A-B, L.2.3, L.2.4.A-E, L.2.5.A-B, L.3-4.3, L.3.4.A-D, L.3.5.B, L.4.4.A-B
Classroom Energy Flow		RI.2-3.10, RI.3.3-4, RI.4.3&10	W.2.7, W.K.2&8	SL.K.1.A, SL.K.3-4&6, SL.1.1.A-C, SL.1.4, SL.2.1.A-C, SL.2.2, SL.3.1.A-B&D, SL.3.6, SL.4.1.A-D	L.K.4.A, L.K.5.A&D, L.K.6, L.1.4, L.1.5.A-B, L.1.6, L.2.3&6, L.2.4.A-E, L.2.5.A-B, L.3-4.3, L.3.4.A-D, L.3.5.B, L.4.4.A-B
Electric Charades	RL.K&3-4.4	RI.K-5.4, RI.2-4.3, RI.3-4.7	W.K.2-3	SL.K-2.1, SL.K.3, SL.K-1.5-6, SL.3-5.3	L.3-5.3, L.4-5.4&6

Cross Reference Charts

Common Core Standards for Mathematics

Activity	Content Standard The *Standards for Mathematical Content* describe the sequence of important mathematics content that students learn. They are a combination of procedures and understandings.	Practice Standard Practice standards ensure students are readily able to understand important concepts, use skills effectively, and apply mathematics to make sense of their changing world.
What the Sun Does for Me	MP5	1.MD.3
Let the Sun Shine Through	MP5	
Shadows in the Schoolyard	MP5	2.MD.1-5
What the Wind Does for Me		
Schoolyard Breezes	MP5, MP6, MP7	
Mapping Wind in the Classroom	MP5	
The “Sun”wich	MP4, MP5, MP6	1.MD.4, 2.MD.9, 3.MD.3
Detecting Schoolyard Food Chains		
Photosynthesis Promenade	MP5	2.MD.1, 2.MD.2
Classroom Energy Flow		
Electric Charades		

Cross Reference Charts

Next Generation Science Standards

Activity	Standard	Practice (SEP) The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems.	Disciplinary Core Ideas (DCI) The fundamental ideas that are necessary for understanding a given science discipline.	Crosscutting Concepts (CCC) Concepts that hold true across the natural and engineered world including: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change.
What the Sun Does for Me	K-PS3-1	Planning and Carrying Out Investigations	PS3.B: Conservation of Energy and Energy Transfer	Cause and Effect
Let the Sun Shine Through	1-PS4-2	Constructing Explanations and Designing Solutions	PS4.B: Electromagnetic Radiation	Cause and Effect
Shadows in the Schoolyard	1-ESS1-1	Planning and Carrying Out Investigations	ESS1.A: The Universe and its Stars	Patterns
What the Wind Does for Me	K-ESS2-1	Analyzing and Interpreting Data	ESS2.D: Weather and Climate	Patterns
Schoolyard Breezes	K-PS2-1, K-ESS2-1, 3-ESS2-1	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Constructing Explanations and Designing Solutions, Connections to Nature of Science, Scientific Investigations Use a Variety of Methods, Science Knowledge is Based on Empirical Evidence	PS2.A: Forces and Motion, PS3.C: Relationship Between Energy and Forces, ESS2.D: Weather and Climate, ETS1.A: Defining and Delimiting an Engineering Problem	Patterns, Cause and Effect, Connections to Engineering, Technology, and Applications of Science, Interdependence of Science, Engineering, and Technology, Influence of Engineering, Technology, and Science on Society and the Natural World, Connections to Nature of Science, Science is a Human Endeavor
Mapping Wind in the Classroom	K-PS2-1, K-ESS2-2	Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Engaging in Argument from Evidence	PS2.A: Forces and Motion, PS2.B: Types of Interactions, PS3.C: Relationship Between Energy and Forces, ESS2.E: Biogeology, ESS3.C: Human Impacts on Earth Systems	Cause and Effect, Systems and System Models
The "Sun"wich	K-LS1-1, 5-PS3-1	Developing and Using Models, Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	LS1.C: Organization for Matter and Energy Flow in Organisms, PS3.D: Energy in Chemical Processes and Everyday Life	Systems and System Models
Detecting Schoolyard Food Chains	K-LS1-1, K-ESS3-1	Analyzing and Interpreting Data, Developing and Using Models, Obtaining, Evaluating, and Communicating Information	LS1.C: Organization for Matter and Energy Flow in Organisms, ESS3.A: Natural Resources	Patterns, Systems and System Models
Photosynthesis Promenade	2-LS2-1	Planning and Carrying Out Investigations	LS2.A: Interdependent Relationships in Ecosystems	Cause and Effect
Classroom Energy Flow	4PS3-2	Planning and Carrying Out Investigations	PS3.A: Definitions of Energy	Energy and Matter
Electric Charades	4-PS3-2	Planning and Carrying Out Investigations	PS3.A: Definitions of Energy	Energy and Matter

Cross Reference Charts

Wisconsin Standards for Environmental Literacy & Sustainability

The activities in this guide address the following Wisconsin Standards for Environmental Literacy & Sustainability which provide a foundational framework that identifies what students should know and be able to do in environmental education. These standards take an interdisciplinary approach to integrating environmental education into multiple subject areas.

Activity	Connect The standard and performance indicators in the Connect strand help students develop and connect with a sense of place while exploring concepts of perspective and mental models, curiosity and wonder, and well-being.	Explore The four standards and corresponding performance indicators in the Explore strand help students understand how ecological principles of networks, nested systems, interdependence, diversity, resilience, cycles, flows, change, and adaptation are present in both natural and cultural systems.	Engage The two standards and corresponding performance indicators in the Engage strand have students investigate concepts of dynamic balance between natural and cultural systems and design and implement stewardship projects as active members of their community.
What the Sun Does for Me	C1.A.e, C1.A.i, C1.B.e, C1.C.e, C1.D.e	EX2.A.e, EX2.A.i, EX2.B.i, EX2.C.e, EX3.B.e, EX4.A.e, EX4.A.i, EX5.B.e, EX5.B.i	
Let the Sun Shine Through	C1.C.e	EX2.C.e	
Shadows in the Schoolyard	C1.A.i, C1.C.e, C1.C.i	EX2.A.e, EX2.A.i, EX5.B.e	
What the Wind Does for Me	C1.A.e, C1.A.i, C1.C.e, C1.D.e	EX2.A.e, EX3.B.e, EX4.A.e, EX5.B.e	
Schoolyard Breezes	C1.A.i, C1.B.e, C1.C.e	EX2.A.e, EX3.B.e, EX4.A.i, EX5.B.e	
Mapping Wind in the Classroom	C1.A.i	EX2.A.e, EX5.B.e, EX5.B.i	EN6.A.i
The "Sun"wich	C1.A.i, C1.B.e	EX2.A.i, EX2.A.m, EX2.B.e, EX3.B.e, EX4.A.e	
Detecting Schoolyard Food Chains	C1.B.e, C1.C.e, C1.C.i	EX2.A.e, Ex2.A.i, EX2.B.e, EX2.B.i, EX3.B.e, Ex4.A.e, EX4.A.i, EX5.B.e	
Photosynthesis Promenade	C1.A.i, C1.B.e	EX2.A.e, EX2.A.i, EX4.A.e, EX4.A.i	
Classroom Energy Flow		EX4.A.i, EX4.B.e	EN6.A.i, EN6.C.e
Electric Charades	C1.A.m, C1.B.i	EX2.A.e, EX2.A.i, EX2.A.m, EX4.A.i	