Lesson 1: In Search of Light

Exploring the Ongoing Role of Light Energy in Human Lives

Overview

In this introduction to the *Energy Lights Maine* module, students consider the ongoing role of light energy in humans' lives. Through a folktale about the Sun, students are reminded that sunlight is the primary source of light energy on Earth. Students investigate a variety of early light emitting devices and consider their benefits and drawbacks.

Teacher Background

Maine has the distinction of being the first place in the country that sunlight touches. While most of us do not think about our relationship with the Sun on a regular basis, light energy plays an important role in the day to day activities of humans. Early humans had an intimate relationship with the Sun as evidenced by the presence of elaborate rituals to protect it and symbolism, folklore, and myths to explain its mysteries. While we know a great deal more about the Sun and the light and heat energy it provides the Earth, humans are still learning new ways to put light energy to work in ways that are most beneficial.

Light is a form of energy. It is called radiant energy because it is radiated by the sun and is made up of several different types of light that scientists have identified as wavelengths of energy that can be used in a many different ways. Like most forms of energy, light energy begins with the Sun. Yet, light is such a common part of modern life that it is often taken for granted. Humans have been devising ways to light up their environment for thousands of years. History shows that humans have accomplished this complex and challenging task in ways that, at first, may seem simple. However, despite advances in technology, not all lighting methods used today are based on new technology.

In this lesson, students examine pictures of "early" light emitting devices. These devices do not use electricity and were used until the invention of the incandescent light bulb. Students become familiar with the devices by reading and discussing the brief descriptions of the images on the cards. Students work together in small groups to determine criteria with which to sort the cards and in a follow up discussion; consider the benefits and drawbacks of these early devices. The intent of this activity is for students to become aware of the variety of methods humans have devised over time to make light available when natural lighting was not accessible and to consider the advances people have made in lighting technologies. As a follow up to the class light card activity, students look for examples of modern light devices and create "modern" light cards. While research into the historical development of light emitting devices is not built into the lesson, the light card activity may spark students' interest in finding out more about the history connected to the light emitting devices featured in the lesson.

Key Ideas

- Light is a form of energy.
- The Sun is the primary source of Earth's light energy.
- Human knowledge and skill to create light emitting devices has evolved throughout history.

Lesson Goals

Students will:

- develop a basic understanding that the Sun is the primary source of Earth's energy, including light.
- explore light emitting devices of the past and consider their benefits and drawbacks.
- make the connection that natural resources are used as sources of light.

Vocabulary

fuel: a substance that can be burned to provide heat or power.

myth: typically, a traditional story of an event that serves to explain a practice, belief, or natural phenomenon.

Preparation

- Determine how to darken the classroom.
- Gather Lesson 1 materials. (See Materials List below)
- Hang chart paper and have markers available.
- Prepare sets of *Early Light* cards. Copy cards on heavy card stock and cut into sets. Put each set in a re-sealable bag. Consider lettering, numbering or color-coding card sets to make reuse easier.
- Preview and practice reading *Raven: A Trickster Tale from the Pacific Northwest.*

Materials

Item	Quantity
Materials to make classroom dark	
Small light such as flashlight or book light	1
Literature: *Raven A Trickster Tale from the Pacific Northwest* by Gerald McDermott	1
Teacher Resource 1.1: *Early Light* Card Sets	1 per group of 3 students
Chart paper, markers, tape	1 set
Scientist's Notebook	1 per student
Student Handout 1.1: Blank Light Card template	1 per student

Time Required: 2 sessions

Session 1: Set up Scientists' Notebooks and read the folktale
Session 2: Do Light Cards activity and homework; Explain day 2

Connection to *Maine Learning Results: Parameters for Essential Instruction*

- Recognize that the Sun is the source of Earth's surface heat and light energy. MLR D2(3-5) e
- Explain that natural resources are limited, and that reusing, recycling, and reducing materials and using renewable resources is important. MLR C3(3-5) e
- Science helps people understand their natural world. MLR C4(3-5)

Teaching The Lesson

Engage

1 Read the sun myth Raven: *Trickster from the Pacific Northwest.*

Make the classroom as dark as possible with all the lights in the room turned off, closing the shades and doors, if possible. Have students in a circle on the floor.

Acknowledge the fact that the lights are off in the classroom. Ask students: *Think about what it might have been like to have classes or simply go about daily activities before the invention of electric lighting?* Allow students share their ideas. Students will most likely make the connection that in very early times the main source of light was the Sun.

Explain to students that the Sun was extremely important but somewhat mysterious to people long ago. Tell them that there were many stories and rituals connected to the Sun and the light it produces. Explain to students that they are going to hear a folktale called *Raven: Trickster Tale from the Pacific Northwest* by Gerald McDermott.

Show the students the book cover and ask them to predict what they think the story is about and why. Accept all answers. Instruct students to listen to the story carefully because at the end of the story they will be asked how the story relates to humans' past understanding of light. With a small reading light on and with great drama, read the *Raven: Trickster Tale from the Pacific Northwest* aloud to the class.

> **Note:** *For background information about the traditional Raven myth, see* ***The Raven Story*** *at Teachers' Domain: http://www.teachersdomain.org/resources/echo07/lan/stories/raven/index.html Consider showing this video clip to students.*

Alternatively or as an extension, you may wish to provide other stories about the sun as the source of light for the Earth. Divide students into small groups and ask each to examine a different title, compare and contrast, and find common themes in the stories.

Other suggested titles include:
Arrow to the Sun by Gerald McDermott
The Way to Start a Day by Byrd Baylor
The Lizard and the Sun by Alma Ada

> **Note:** *Students are intrigued by stories. When stories, including myths and nonfiction accounts, are told in the context of a science lesson, it broadens their view of how people perceive events or generate ideas about how things happen. The Raven story helps children realize that humans in the past were puzzled by the Sun and the light it produced, thinking it was magical and mysterious. The main idea to bring forth from this story is that light from the sun has always been and will remain very important to humans.*

2 Discuss the sun myth.

Turn on the lights and ask,

- *Why do you think people of the past made up stories like the Raven?* (Myths, legends, and folktales were often created to explain phenomenon people did not understand. Typically stories offered explanations about events in nature.)
- *Why do you think the Raven was chosen to be the giver of light?* (See author's note found at the front of the book.)
- *What parts of the story tell us the Sun is important to the people?* Lead a short, open discussion of the story, accepting all answers.

> **Note:** *Why accept all answers when some may not be correct? At this point in the lesson, the goal is engage all students and initiate the sharing of ideas. Creating an environment where all ideas are accepted will aid in this. Questioning techniques such as "What do you think this story is about?" rather than "What is the story about?" will help create that atmosphere. This discussion provides an opportunity to assess students' current thinking which will guide future conversations.*

Explore

3 Examine *Early Light* cards.

Students return to their seats where they can work together in small groups of 3. Explain that, unlike earlier times, humans have a greater knowledge of light energy. Humans have learned how to create light emitting devices to use when sunlight is not available or is limited.

Give each group a set of *Early Light* cards. Direct students to read and discuss the information on each of the cards. Challenge students to sort the cards in a way that makes sense to them. Explain that each group member should have the opportunity to suggest his or her card sorting ideas before the group decides on final groupings.

Note: *As students sort their cards, circulate around the room, making note of their conversations. Their conversations are just as important as the final grouping they choose. One of the purposes of the Early Light card sort activity is to promote divergent thinking and open discourse while exploring the historical use of light. Divergent thinking is a type of thinking that can use content as a vehicle to prompt diverse or unique thinking among students and allow them an opportunity to examine different perspectives.*

Some students, however, may experience difficulty in thinking of categories in which to sort the cards. Teachers may want to provide prompts such as, How are these two cards alike? Can you find any other cards that are alike in the same way?

This purpose of this activity is to promote critical and creative thinking. It is not about being right or wrong, as there are no right or wrong ways to sort the cards. Reassure your students of this before they begin and reinforce it throughout the activity. As students view other groups' cards they will see that there are, in fact, many ways to organize them. Examples include: timeline, human vs. machine vs. natural, how much fire/light it produces, natural vs. electric vs. oil light, etc.

Keep in mind that some of the information on the Early Light cards may be challenging for some students' at this grade to read and understand. It may be helpful assign students to groups that have a mix of reading abilities.

Reflect And Discuss

4 Discuss *Early Light* cards.

Once the groups have finished sorting the cards, explain to students that they will walk around the room and view their classmates' groupings. Ask these questions to provide a focus:

- *What were some of the ways your classmates grouped the 'Early Light' cards?*
- *Do humans still use these methods to generate light today? Why or why not?*

Gather the students to discuss the questions. The purpose of this discussion is to guide the students' thinking toward the idea that these devices may not be safe, economical, environmentally friendly, and/or convenient ways to generate light. Humans used and continue to use the resources and technology that is available to them, and there are pros and cons of each resource.

> **Note:** *Students may group the Early Light cards in a variety of ways. Cards could be grouped according to the fuel source used such as oil, gas, pitch, wood, etc. Students may choose to group the cards following an historical timeline or use some other criteria. Accept all ideas and pay particular attention to students' conversations, listening to the ideas they have about the card groupings.*

Summarize the grouping patterns used by the class. Acknowledge that humans have improved lighting technology and continue to do research and seek out improvements.

5 Introduce *Modern Light* cards.

Direct students to look for 3-5 different present-day light emitting devices around their homes and communities. These could be light bulbs, fixtures, or other light emitting devices. Provide each student with a blank *Light Card* template that they can complete by including a drawing or photograph of the "modern" light and a brief description of the light emitting device. Challenge students to find particularly interesting lights and encourage students to elicit the help of family members with this assignment.

In the classroom, after students complete this out-of-class assignment, have them sort their *Modern Light* cards and/or put their cards on display, perhaps affixed to a poster.

6 Bring lesson to a close.

Ask students to respond to the following prompt in their scientists' notebooks:

- List three things you learned about light.
- Record two questions you have about light.

Planning Ahead

In preparation for Lesson 2, teachers should collect student notebooks and compile their questions on chart paper.

Extensions

Student may:

- View NASA Goddard's Sun for Kids online video (approximately 6 1/2 minutes) which describes early "sun" ideas and segues into the tools NASA uses to make observations and learn more about Earth's most important star. http://learners.gsfc.nasa.gov/mediaviewer/SunForKids/
- Visit NASA's Sun-Earth Connection Education Forum for educational materials, multimedia presentation, and "Ask a Scientist" link. http://sunearth.gsfc.nasa.gov/edsecef.htm
- Explore other light myths including:
  Arrow to the Sun by Gerald McDermott
  The Way to Start a Day by Byrd Baylor
  The Lizard and the Sun by Alma Ada
- Research various ancient cultures' connection with the sun. Egyptians, Incas, and Aztecs built extensive structures explicitly for sun worship.
- Conduct follow up research about the light emitting devices featured in the *Early Light* cards.
- View Wired Magazine's Gallery: A Brief History of Light http://www.wired.com/gadgets/miscellaneous/multimedia/2008/11/gallery_lights
- Start a small indoor garden which could lead to investigations about plants' dependence on the sun.

Connection to Maine Agencies

MEEP (Maine Energy Education Program) has a *Great Energy Debate Game (4th to 12th grade).*

- What are the pros and cons of renewable versus nonrenewable resources?
- Do students have any preconceptions as to which energy sources are the best?

In this debate, students take on the real world challenge of convincing others that one energy source is the best. A MEEP representative and will come to interested schools, free of charge, to guide this activity. The MEEP website is http://www.meepnews.org/classroomactivities

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a visit contact Nancy Chandler at 207.760.2556 or nchandler@mainepub-licservice.com.

Online References and Resources

http://www.wired.com/gadgets/miscellaneous/multimedia/2008/11/gallery_lights

Early Light Cards Credits

Images used in accordance with Flickr.com's Creative Commons License.

Oil Lamp (1st Century style)_0748 by hoyasmeg
http://www.flickr.com/photos/emeryjl/508092884/

Making Fire by archival
http://www.flickr.com/photos/archivalproject/100298296/

match 2 by hamad M
http://www.flickr.com/photos/meshal/42437034/

Gaslight sunset, Liverpool by Esk
http://www.flickr.com/photos/22081583@N06/2786516065/

Campfire by AviatorDave
http://www.flickr.com/photos/aviatordave/23057736/

Candlestick by YlvaS'
http://www.flickr.com/photos/ylvas/444856880/

The Flame Still Burns by Strychnine
http://www.flickr.com/photos/strychnine/109801738/

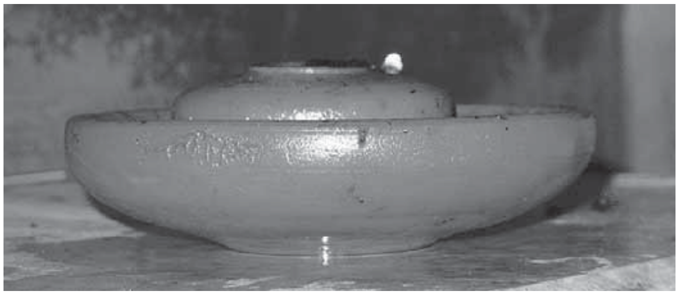
Flint Knapper 1 by Wessex Archaeology
http://www.flickr.com/photos/wessexarchaeology/56515302/

Marshall Point Light House by brentdanley
http://www.flickr.com/photos/brentdanley/767640663/

Biggest Light Bulb by St Stev
http://www.flickr.com/photos/st-stev/2289828067/

Image of Betty Lamp used with permission from Jim and Beth Boyle of http://www.ramshornstudio.com/early_lighting_1.htm

Image of kerosene oil-ceiling lamp used with permission from Maine State Museum http://www.maine.gov/museum/



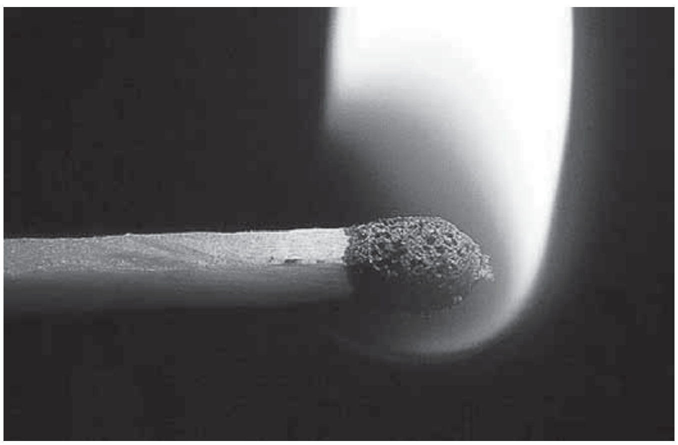
This small pottery lamp made out of clay burned animal fat and plant oils. Lamps like these were first used in the first century A.D. by Egyptians. Some of the oldest oil lamps were made using rocks and shells.

Using oil as a fuel for light can be difficult to do. The oil must be very hot before it will burn. *Why would this be a problem?*

People learned to use a "wick" – a thin cord of absorbent material that soaks up the oil so that it burns a little at a time. Rock, shell, and pottery lamps were the first step toward the invention of the oil lamp.

A stick rubbed very quickly against another piece of wood can become hot enough to make tinder catch on fire. *How does this happen?*

Native people mastered the art of starting a fire without matches using a fire plough and hearth or bow and hand drill. These techniques are still used by people today, including Maine sportsmen and sportswomen today.



Did you know that matches create a flame by a chemical reaction? Match heads are coated with a material called phosphorus. This phosphorus ignites from the heat of the friction as it is struck against a surface.

Early matches sometimes caught fire without being struck at all! That surely does sound dangerous. Modern "safety" matches work only when struck against the matchbox.

During the 19th century, American cities and towns used gas lamps to light their streets. Because of this streets were finally able to be lit at night. People were glad that their streets weren't so dark anymore.

These gaslights were made from iron and copper and had to be lit by hand. These street gas lamps gave off a bad odor and burned dimly. Later, gas lamps were made with "mantles." Mantles are small net like bags that are coated with a chemical that makes them glow brightly when heated.

Firelight gave humans the first portable light. Wood has long been the traditional fuel for fire. The color of the flame can change depending on what is being burned. In order to keep a fire burning, it needs to have a continuous source of fuel.

Using fire indoors for light can cause a lot of smoke which make it difficult for some people to breathe easily. Fire is also difficult to contain and if not contained properly it can destroy homes.

The word "candle" comes from a Latin word meaning "to shine." A candle can be thought of as an oil lamp with solid oil. Before the 1800s candles were often made of tallow (animal fat) or beeswax. Because they could be made at home many people used them to light their homes. These candles produce a lot of smoke but little light.

Many people use candles today as decorations, for their scent, or as emergency lighting. Candles are rarely used on a regular basis today to light homes because of the danger of causing house fires.

Before the invention of gas lighting, lamps that burned oil were common. Oil came mainly from the fat of sea animals, such as whales, seals, and even penguins. The oil was boiled down in huge vats to make "tallow." This Betty Lamp, found in a hunting camp in Maine, was fueled by pine pitch.

Flaming torches allowed light to be fastened to walls or carried from place to place. When Maine forts were in operation they were lit using torches. Poles topped with burning tar or rags gave off a bright yellow light. The open flame, fumes, and intensity of light made use of torches dangerous indoors.

Flint and iron pyrite are two minerals that give off sparks if they are hit with something hard. They were probably the first pieces of fire making equipment used by our ancestors.

To produce a fire, the sparks had to land on tinder – a dry, light material such as wood dust, feathery plant seeds, or fungus. Flint and iron were later used to ignite gunpowder in "flintlock" riffles.

Can you imagine Maine without lighthouses? What would the ships do? Can you also imagine a single wick emitting as much light as seven candles?

Well that's exactly what the first style of lamp used to light lighthouses did! The wicks were not only circular but they were hollow. The hollow design allowed air to move up inside the wick as well as all around it allowing more air. Later, reflective plates were placed behind the lamp making the light brighter and able to be seen further away.

This photo from the Maine State Museum shows a wick style kerosene oil-ceiling lamp from a Maine kitchen around the turn of the 19th century. The small, white fuel tank houses the oil, which is sometimes called paraffin. A cotton wick is partially submerged in the oil. Once the top of the wick is lit, a yellowish flame is produced.

On October 21, 1879 lighting changed forever. Thomas Edison's perfection of the incandescent light bulb dramatically changed how many people obtain light. This is the biggest filament electric light bulb in the world. It is located at the Toshiba Science Museum in Kawasaki.

Lesson 2: Circuits and Electric Light

Overview

Students begin this lesson by examining the components of a portable light device- a battery operated flashlight. This initial exploration and the discussion it generates are used to begin a guided exploration of simple circuitry. Students attempt to light a bulb using a battery, a wire, and a light bulb. Students keep a record of each attempt using words and sketches, noting which ones are successful and which are not.

Teacher Background

Who hasn't stayed up late, past the bedtime warning, secretly reading a favorite book using a flashlight under the bedcovers? This lesson uses a simple and familiar light device, a battery operated flashlight, to introduce elements of simple electrical circuits. Exploration with simple materials such as batteries, bulbs, and wires allows students to begin building knowledge of a sophisticated and challenging concept, energy, in a tangible way. While energy cannot be seen, its effects can be seen. An understanding of energy is developed through direct experiences.

Learning about circuits is primarily observational at this grade span and provides students with the opportunity to begin to consider why electrical devices are designed the way they are. Students can apply their knowledge of simple electrical pathways to larger systems and being to consider what components must be in place in order to "light Maine" efficiently, safely, and economically.

As in many other electrical devices, flashlights house the components of simple circuits. A circuit is an unbroken path or closed loop, which allows an electrical energy to flow. The flashlight's components include a pathway for electric current. In a flashlight, the electric current goes through the metal wire (attached to a switch), through the metal spring, through the batteries, through the base of the light bulb, across the filament of the light bulb, and through the side of the bulb. Without this complete pathway the flashlight will not light.

In addition to a pathway, electrical currents do not flow without an energy source. Portable flashlights, such as the one explored in this lesson, often use batteries as their electrical energy source. Batteries contain chemicals that react, acting like a "pump" to move electrical charges through the circuit. The electrical charges were already present in the wires, bulbs, and receiver – the battery gets them moving. Many people think that batteries (and generators) send out a substance that gets "used up" but this is not true. When batteries "die" they do not "run out of electricity" but rather the battery's chemical reaction fails to fuel the movement of the electrical charge. It is not expected that students understand how or that batteries move electric charges. This information is provided to augment the teacher's background knowledge.

Circuits are typically constructed to utilize electrical energy transfers to a receiver to create some sort of an "effect"- lighting a bulb, making something move, producing sound, and the like. Presenting students with the idea that energy is needed to make something happen and that the "needed" energy comes from an energy source, provides an early experience that students can connect to when they encounter energy transformations in later grades.

At the beginning of this lesson, students share their initial thinking about how they might use one wire and a battery to light a bulb. There are several ideas that students often bring initially to this task. One of the more common ideas, known as the "source-consumer" model, reveals that students believe that the battery gives something to the light bulb. Students often show this by drawing a single wire attached to one (usually the top) terminal of the battery and the other end attached to the bulb. A similar model involves using two wires, each attached to each end of the battery and the bulb – each with wire carrying energy from the battery to the light bulb. (Driver et al. 1994)

Key Ideas

- A complete path to and from a source is needed for an electric current to flow.
- The flow of a complete electric current can produce light.

Lesson Goals

Students will:
- determine how to light a bulb with a battery and wire.
- recognize that electric current needs to travel in a complete loop in order to light a bulb.
- identify the essential components of a circuit including a pathway and a source.
- draw a complete circuit needed to light a bulb.

Vocabulary

circuit: a complete pathway or loop for electricity to travel (flow).

Preparation

- Prepare a basic circuit kit of materials for each student. (See Materials List below)
- Test batteries and bulbs.
- Using wire stripper, cut wire into 12" pieces and strip the end inch off of each strip. For those unfamiliar with stripping wires, review the "how to" video clip on the *PowerSleuth* website: www.powersleuth.org
- Try the four configurations that work to light a bulb using one wire and battery.
- (Optional) Prepare an overhead of Teacher Resource 2.1.

Materials

Item	**Quantity**
Wire stripper	1
Flashlight with batteries	1
Basic Circuit Kit: • Wire, 22-gauge, insulated (one 12" piece, stripped) • D battery • Replacement incandescent flashlight bulb	1 per student (Have spare materials on hand)
Scientist's Notebook	1 per student
Chart paper and markers (optional)	1 set
Teacher Resource 2.1: Simple Circuit Configurations	1

Time Required: 2 sessions

Connection to *National Science Education Standards (NSES)* and *Benchmarks for Science Literacy (BSL)*

- Electricity in circuits can produce light, heat, sound and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass. NSES B(K-4)
- Offer reasons for their findings and consider reasons suggested by others. BSL 12A (3-5)
- Keeping records of their investigations and observations and not change the records later. BSL 12A (3-5)

Teaching The Lesson

Engage

1 Share ideas and questions about light.

Post the compiled class question list (from Lesson 1, step 6) in a place where it will be visible throughout the module. Acknowledge the interesting variety of questions about light the students generated as a class. Explain to students that this list will remain posted for the remainder of the module and encourage students to add to the list as new questions arise.

Ask students to share their home/school assignment findings from Lesson 1:

- *What kind of lights did you find at home and/or around your community?*
- *In what ways are the lights/lamps similar to or different from each other?*
- *Which ones use electricity or batteries?*

2 Introduce batteries from battery-operated flashlight.

Show the class a traditional battery operated flashlight. Open the flashlight and remove the batteries. Try to shift the ensuing conversation towards the idea that batteries are a common way to power lights.

- *Are all batteries the same? If not, how are they different?*
- *What do the batteries do?*

As in Lesson 1 during the Engage stage, accept all answers and use this opportunity to listen to students' thinking as a way to guide questioning and discussions during this lesson.

3 Introduce the components of a simple circuit.

Show students the inside of the flashlight. Consider passing the flashlight around to allow students to take a closer look at the flashlight parts or arrange students in groups prior to this initial discussion and give each group a flashlight of their own to explore during the introduction. Explain to students that their challenge is to make a flashlight bulb light up using its individual parts which will be provided. Hold up a battery, a light bulb, and one wire. Provide a little background about each of these components:

• Batteries, in this case two D cells, power the flashlight. They are the source of electricity for the flashlight. Students who are familiar with batteries may bring up the idea that batteries contain chemicals and metals that react with each other to generate electricity.

• A small light bulb is the type used in flashlights. In order to light up, the bulb needs to receive an electric current.

• Flashlights have a wire, a pathway, to keep the electric current flowing. Consider asking students: *Where is the wire in a flashlight?* (The wire is often hidden in flashlights.)

Before students begin exploring, ask them to open their scientists' notebooks and use words and sketches to describe how they think they could light the bulb using the wire and battery. Reassure students that this is a prediction based on what they currently know and that it is alright if they are not sure. Remind students that they should support their prediction with reasoning.

Explore

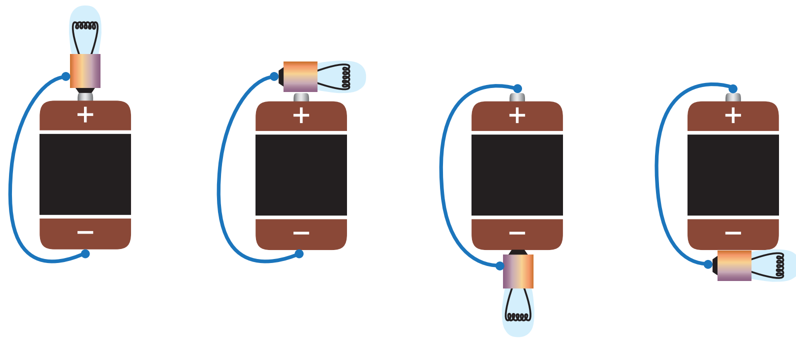
4 Build a circuit.

Explain that each student will build a circuit using one battery, one bulb, and one piece of wire. During the investigation, students are to make accurate drawings of their attempts, noting those which work and those that do not work.

> **Note:** *Emphasize the importance of recording observations and the results of attempts that seem "unsuccessful." This information will be a valuable reference for students as they use it to discuss and reflect upon their experiences and build their knowledge of simple circuitry ideas. Explain that new discoveries in science often result from paying attention to what doesn't work.*

It may be helpful to demonstrate simple but effective ways to draw the key parts of battery, bulb, and wire involved in the circuit. Ask students to focus their drawings on the parts that are important to the functionality of the circuit and to avoid spending too much time drawing irrelevant details such as the designs or lettering on the battery.

Allow time for students to explore. Encourage them to use each other as resources and challenge students to find as many ways as possible to light the bulb. (There are four configurations that work.)



As students work, circulate around the room, helping students focus their attention on determining the various critical contact points on the battery and bulb. Students will most likely be familiar with the two different ends (+ / -) of their batteries but may not carefully observe the contact points involved on the light bulb (connections must be made to the side and base of the bulb). Remind students to record all their attempts and note these contact points.

> **Note:** *Students that finish early can be given a second wire to use in constructing circuits.*

Reflect And Discuss

40

5 Discuss findings during a science talk.

Ask students to bring their scientists' notebooks and sit in a circle. Have chart paper or a clean section of a white/chalk board available for students to share their findings and keep a wire, bulb, and battery on hand in case students need to demonstrate their findings.

> **Note:** *For students who are developing language and vocabulary, presentations that include drawing, explanations, and demonstrations provide a visual / oral connection. For example, students with the same configurations make presentations in teams for their classmates, one team member drawing while the other explains and demonstrates.*

The purpose of this discussion is to examine students' findings and to guide them to common understandings about circuits. Rather than "telling" students the information, the teacher's role is to facilitate a student discussion to elicit these common understandings. One way to initiate this discussion would be to ask students to examine their drawings first with an elbow partner, then as a full group, to see if they notice any patterns in the configurations that worked:

Ask students:
What do the configurations that lit the bulb have in common?

Elicit:

- A complete pathway or loop is needed for an electric current to flow. The configurations that light the bulb have a complete loop.
- Circuits have a pathway and energy source (battery).
- There are specific contact points for each of the components of the circuit that need to be connected in order for electric current to flow and light the bulb. The critical contact points for the battery are the "bump" on the top of the battery (the positive side of the battery) and the bottom flat metal part of the battery (the negative side of the battery). The critical contact points for the light bulb are the metal side of the light bulb (threaded) and the metal bottom tip of the bulb. The wire, battery, and bulb must be configured in such a way that these critical contact points are connected in a loop. (Refer to the diagrams in this lesson of the four configurations that work.)

Ask students:

What shape do configurations that lit the bulb have in common?

- There is a loop, circle, or pathway.

> **Note:** *If asked what would have helped them make the connection easier, students may suggest a battery holder and something to clip the wires to the bulb.*

Students may wish to draw on chart paper or on a black/white board or use the materials to clarify their discoveries. As students make additional suggestions, follow up with questions such as:

- *Why does it matter where the bulb, battery and wire touch?* (There are only certain places that allow the flow of electricity – these are the critical contact points.)
- *Why do you think a configuration worked or did not work? How could this configuration be rearranged so that it would work?* (Students should consider whether or not the components were connected in a loop and in such a way that the critical contact points were aligned.)

Encourage students to support their thinking with evidence collected in their notebooks. Ask students to add to their notebooks any new configurations that worked which they had not previously recorded.

6 Introduce the term circuit.

A circuit is a complete path for electricity to travel. Distinguish between open and closed circuits. An open circuit is an incomplete loop that will not light a bulb. A closed circuit is a complete loop that will light a bulb, as long as all the parts are functional.

Consider writing the word "circuit" on the board. Underneath the word circuit, list the words "circle" and "circus." Ask students to identify what these words have in common. (The root "circ").

Discuss with students how these words are related. Students could brainstorm additional words and discuss their meanings.
(Ex: circulation, circa, etc.)

Help students "see" the circuit in the flashlight that they examined at the start of this lesson. Show students the flashlights again and initiate a discussion about the following questions:

- *Describe the complete circuit in this flashlight.* (Students should be able to recognize and trace the pathway of electricity in the flashlight. The flashlight has the same basic components as the circuit. The flashlight has additional components that aid in keeping the critical contact points held tightly together and/or enhance the effect (ex: reflector around the bulb makes the area cast by the light greater). The wire in the flashlight is often a wider band of metal and connected to a switch making it easier to turn off and on the light.
- *How could any of the configurations that we discovered that lit the bulb be used as a "flashlight?"* (Any of the configurations would work.)

Discuss with students the practicality of the idea of using their simple circuits as flashlights. Ask students to think about the similarities and differences between the configurations they discovered versus the components of the flashlight. It may be helpful to ask student to think about some of the difficulties they encountered as they tried to light the bulbs. Students may mention that the wire, bulb, and battery were difficult to hold in place to make a connection. If students do not mention that using a bulb, battery, and wire as they did during the investigation isn't particularly practical, suggest this to the students. Ask students what added parts make the flashlight easier to use (has a bulb holder, reflector, switch, "housing") and/or more attractive to people (style, color, grip, etc.). Be sure to confirm that the flashlight has essentially the same components as their configurations (bulb, wire, and battery) to make a complete circuit.

7 Bring lesson to a close.

Ask students to review their initial sketches (prediction) made prior to the exploration with the battery, bulb, and wire. Ask students to explain why their initial idea about a circuit did or did not work. Were their configurations complete circuits? Why or why not? Encourage students to use words and sketches to explain their thinking. Students may find it helpful to demonstrate their ideas with materials.

> **Note:** *Students will be examining the interior of light bulbs and exploring the role of switches in Lesson 3. It is not expected that students include these details in their drawings at the close of this lesson.*

Extensions

Student may:

- use a second wire to discover configurations that work using two wires, a battery, and bulb.
- investigate series and parallel circuits.
- explore the circuitry involved in toys or other familiar devices that light up, i.e. spinning tops, sneakers that flash when people walk, and "energy balls."
- build a simple flashlight. Directions can be found on the Energizer battery website: http://www.energizer.com/learning-center/science-center/Pages/make-flashlight.aspx
- take a virtual tour of a flashlight museum: http://www.flashlightmuseum.com/ or view a vintage flashlight collection: http://www.wordcraft.net/flashlight.html
- make a battery using various fruits and vegetables: http://pbskids.org/zoom/activities/sci/lemonbatteryii.html
- construct a a potato clock: http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.com/collection/cub_/activities/cub_energy2/cub_energy2_lesson04_activity2.xml
- watch the Dragonfly TV clip about Body Electricity: http://pbskids.org/dragonflytv/show/bodyelectricity.html

Connection to Maine Agencies

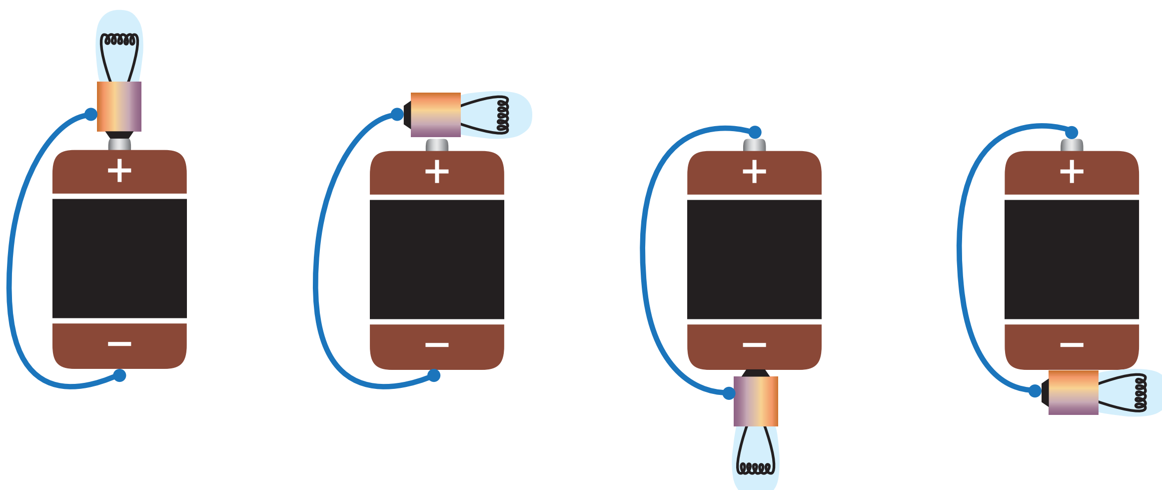
MEEP (Maine Energy Education Program) has an Apple Battery exploration and will come to interested schools, free of charge. Students experiment with making a battery by inserting different types of metals into an apple and measuring the electrical current they generate. The MEEP website is http://www.meepnews.org/classroomactivities

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a visit contact Nancy Chandler at 207.760.2556 or nchandler@mainepublic service.com.

Online References and Resources

How to strip electrical wire:
http://www.youtube.com/watch?v=0rY6KwyyekU

Simple Circuit Configurations



Lesson 3: A Systematic Look at the Incandescent Light Bulb

Overview

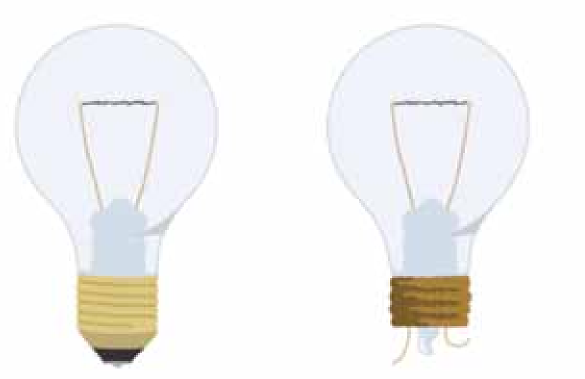
Through first hand observations of an incandescent light bulb, students discover its internal components. Students expand their circuitry knowledge by considering the pathway of electrical energy through a light bulb and by incorporating the bulb into an electrical system – a complete circuit. They also explore the concept of a system by considering the implications of a nonworking component of a light bulb.

Teacher Background

Imagine life without light bulbs. The incandescent light bulb is an ingenious device that changed the way humans live. While many scientists contributed to the invention of the light bulb, it is Thomas Edison that is most often recognized for perfecting the incandescent bulb. Edison not only invented a practical light bulb, but he used his knowledge of electricity and gas lighting to invent an entire system of electrical lighting. This system included bulbs, generators, and wires. Edison's light bulb invention was not without great controversy.

The word "incandescent" refers to "white, glowing, or luminous with intense heat." Incandescent light bulbs are composed of several internal structures that work together to produce light and heat. The structure that emits light is called a filament. This tiny, horizontal, thin wire that is supported at the end of two small vertical wires gets very hot (as hot as 4500 degrees F!) when an electric current passes through it and thus emits light. Filaments are often made of tungsten. Tungsten is a metal with a very high melting point (point at which it will melt or catch fire). Incandescent bulbs have several other key parts including a glass cover, 2 support wires that attach to either end of the filament, a wire attachment point, a ceramic insulator, and a metal tip. Inside the light bulb is an inert gas, such as argon, that prevents the metal from coming into contact with oxygen and thus prevents the filament from burning out.

Exploring parts of a light bulb offers an experience in systems since a light bulb is a very common example of a system. A system can be described as a set of interacting parts that work together to form a unified whole. Human-made systems usually have a certain purpose and are designed to work as a coherent entity.



As with parts in any system, if one or more parts of a bulb were missing or not working, the light bulb would not light up. For example, if the filament breaks or burns out, the circuit is no longer complete and the bulb wouldn't light. To prevent this filament from burning out, it is encased in an oxygen free glass bulb. This oxygen free chamber prevents combustion and erosion of the filament. The prevention of combustion is a reaction between the very hot metal of the filament and oxygen, if it were present. Other parts of this light bulb system include the two contact points that are present at the side and base of the bulb. These contact points allow the electrical current to enter and exit the bulb. They connect to two wires that attach to the filament, which is held up by a tiny glass mount that comes up through the center of the bulb. The metal base hides the place where these wires touch, making it difficult for students to conceptualize the wires' role in completing a circuit. All of these seemingly simple parts have a function in providing a complete pathway for the electrical energy or current to move through the light bulb. Remember, in order for a light bulb to light up, it needs to be part of a complete circuit. If the bulb has broken parts or is arranged or connected improperly in an electrical system, it will not light up.

Switches offer a safe and simple way for users of lights and other electrical devices to open and close the circuit to and from the device. By switching open the circuit the light can be shut off. By switching the circuit closed the light can be lit.

Upper elementary students should be given the opportunity to explore the parts of a system and how they work together. Exploration of a system should include explaining ways that things may not work well (or at all) if a part or parts are missing, broken, worn out, mismatched, or misconnected. While these experiences are an early introduction to systems, it is not expected that students identify the light bulb as a system per se but rather develop the sense that individual parts working together can do more than each part individually. Furthermore, while students are introduced to the names of the parts of the light bulb, the intent is not to have students memorize these terms. The parts are identified for the purpose of aiding class discussions and other forms of communication.

While the incandescent light bulb is slowly being replaced with a new generation of energy saving compact florescent devices and LEDs (light emitting diodes) it offers a "look" into the components of a common electrical device. This focused look at incandescent light bulbs assists in developing a small-scale understanding of an electrical system and prepares students for examining electrical systems on a larger scale.

Students will undoubtedly state that there are a wide variety of light bulbs available. A walk down the aisle of a local hardware store will reveal the different choices, such as incandescent bulbs, halogen bulbs, compact florescent bulbs, LEDs, and an array of others. Alternative lighting choices will be introduced in later lessons.

Key Ideas

- Light bulbs are made up of smaller parts, each with its own function. The parts work together to light the bulb.
- In a complete circuit, electrical energy not only flows to the light bulb, but through the light bulb.
- If a part of the bulb or circuit is missing, broken, worn out, mismatched, or misconnected, the circuit will not be complete.
- Many circuits incorporate switches. The simplest switch has two metal contacts that, when touching, complete the circuit and allow electricity to flow and, when separated, break the circuit and not allow the electricity to flow.

Lesson Goals

Students will:

- recognize that light bulbs have parts and that the parts work together (as a system).
- describe the flow of electrical energy through a light bulb.
- explain how a simple switch can be used to control the flow of electrical energy.

Vocabulary

circuit: a complete pathway or loop through which electricity travels.

filament: a thin thread of metal, often made of tungsten that becomes very hot and emits light as an electric current passes through it.

incandescent light bulb: a source of light that emits light as an electric current is passed through a thin filament which glows with intense heat.

open circuit: an incomplete pathway or loop that interrupts the flow of electricity.

closed circuit: a complete pathway or loop that allows electricity to travel.

switch: a device that allows circuit to be connected and disconnected.

system: a set of interacting parts that work together to form a unified whole.

Preparation

- Prepare materials. (See Materials List below)
- Test batteries and bulbs in student's basic circuit kits.
- Become familiar with the internal components of the different styles of incandescent light bulbs.
- Make an overhead or poster of the light bulb diagram and desk lamp diagram.
- Cut additional wire into 12" pieces and strip off the plastic coating 1" from each end.
- Preview video clip used in step 4. (Students will view the first 55 seconds of the clip.)

Materials

Item	Quantity
Wire stripper	1
An assortment (4-6 different styles) of incandescent light bulbs (e.g. flashlight bulb, holiday replacement bulbs, decorative flame or teardrop shaped bulbs, etc. Avoid bulbs with frosted or colored glass.)	1 set per group
Trays or boxes (for distribution of bulbs and to prevent bulbs from accidental breakage)	1 per set of bulbs (to contain the set) and individual ones for students to place bulbs on as they making observations
Hand lens	1 per student
Safety goggles	1 per student
Scientist's Notebook	1 per student
Colored pencils	1 set per group
Access to LCD projector, laptop, speakers, internet (to show light bulb video clip)	1 per class
Basic Circuit Kit: • Wire, 22-gauge, insulated (one 12" piece, stripped) • D battery • Replacement incandescent flashlight bulb	1 per student (Have spare materials on hand)
Supplementary Circuit Components: • Bulb holder (some bulb holders may require a Philips head screwdriver) • Battery holder • Two additional 12" pieces of wire, stripped	1 set per student (Have spare materials on hand)
Switch Components • Index card • Two brad fasteners • Two paper clips	1 set per student
Teacher Resource 3.1: Incandescent Light Bulb Diagram	1
Teacher Resource 3.2: Desk Lamp Diagram	1
Desk or Clamp Lamp (prop/optional)	1
Student Handout 3.1: The Light Bulb Problem	1 per student
Extension cord	1

Safety Notes

To prevent bulbs from rolling off the tables or desks, it is recommended that bulbs be kept in a box or tray. Make suggestions as to how students should handle bulbs and what should happen in terms of clean up/disposal if one should break. Goggles should be worn when working with objects that can break and shatter such as light bulbs. Keep a dust pan and broom on hand to sweep up any broken light bulb glass.

Time Required: 2-3 sessions

Session 1: Investigate light bulbs, diagram and label parts and discuss the pathway of electricity through the bulb, steps 1-4.

Session 2: Construct a complete simple circuit, construct and incorporate switch into the circuit.

Session 3: Complete Student Handout 3.1.

Connection to *Maine Learning Results: Parameters for Essential Instruction (MLR)* and *National Science Education Standards (NSES)*

- Give examples that show how individual parts of organisms, ecosystems, or human-made structures can influence one another. MLR A1(3-5) a
- Explain ways that things including organisms, ecosystems, or human-made structures may not work as well (or not at all) if a part is missing, broken, worn out, mismatched, or misconnected. MLR A1(3-5) b
- Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass. NSES B(K-4) 10

Teaching The Lesson

Engage

1 Uncover student thinking.

Hold up a light bulb and pose the following question: *How do you think electricity travels through the light bulb?"*

Ask students to take a few moments to use words and sketches to describe their thinking about the path electrical energy takes through a light bulb.

Ask a few students to share their current thinking about how electrical energy moves through a light bulb. Pay close attention to the ideas students share. Most students probably have not thought about the pathway electricity takes through the bulb. The metal casing at the bottom of most light bulbs prevents students from observing the presence and position of the two contact wires that are part of a complete circuit. A close examination of the components of the bulb involved in the pathway of electrical energy through a complete circuit will be explicitly addressed in this lesson.

Explore

2 Observe and sketch light bulbs.

Distribute a hand lens to each student and an assortment of incandescent light bulbs (in a tray to prevent rolling off the table) to each group of students. Instruct students to examine the various bulbs, noting similarities and differences through words and sketches in their notebooks.

3 Examine parts of light bulb.

Ask students what they noticed about the different light bulbs. Call attention to the fact that light bulbs are made up of smaller parts. Ask, *"What parts do all of the bulbs seem to have in common?"*

Students should notice that each bulb has a filament, two support wires, a glass base, and wire contact points. Ask students to comment on why they think these parts are found in all the bulbs. (All of these parts are involved in the pathway of electrical energy through the bulb.) Discuss how the parts of the bulb are related to the critical contact points observed and discussed in Lesson 2. The main focus of this discussion is to help students begin to see how the parts of a light bulb provide a pathway of electrical energy and how the pathway of electricity flows through the light bulb when part of a simple circuit.

4 Explore pathway of electrical energy.

Show students the diagram of the parts of an incandescent light bulb, Teacher Resource 3.1. Ask students to draw a cut away view label the key parts of the bulb (filament, glass cover, wires, metal base, (glass) support, gas, contact points). Remember, the intent of asking students to add labels to their light bulb diagrams is not to have students memorize the parts of an incandescent light bulb, but rather to aid communication. Trace the path of electrical energy through the parts of the light bulb. Ask students to add a colored line and arrows showing the pathway of electricity through the bulb in their own drawings. This one minute video clip can be shown to reinforce the pathway of electric current takes through a light bulb: http://www.youtube.com/watch?v=YnMP1Uj2nz0

> **Note:** *Students view the first 55 seconds of the clip. The last few seconds of the clip shows the bulb exploding and is unnecessary and potentially distracting for students. Use the clip to help students recognize how electric current travels through the bulb and as a result, the filament gets hot and glows. Be aware that because the only evidence of the pathway of electricity that students can readily see is the glowing filament. Students may think that the wires leading up to the filament are not part of the circuit. Clarify with students by questioning them as to why only the filament "glows" and not the whole circuit.*

Following the clip, students pair up to share and discuss their sketches that show the path electricity takes through the bulb (peer check in). Check to see if students have questions or found discrepancies in their sketches. Clarify questions and/or rectify discrepancies. Summarize once again the complete electrical pathway to reinforce the idea that electrical energy must pass through the identified parts of the bulb in order for the bulb to light.

Students, still working in pairs, first discuss and then describe individually in their notebooks how the smaller, individual parts of the bulb work together to accomplish the task of emitting light. Once students have completed this task, students talk with their partner and list three specific examples of what might happen if certain parts of the bulb were missing, broken, or worn out. For example, students are probably familiar with burned out light bulbs. Incandescent bulbs often burn out because the filaments wear out and break, which causes a disruption in the electrical flow. After students have completed this task, ask a few pairs to share their examples with the class.

5 Construct an electrical circuit.

Hold up a light bulb again and ask, *"Why doesn't the bulb light?"* Confirm that in order to light the bulb, electricity must follow a pathway through the battery, wires, and bulb, making a complete circuit. Give each student a kit of materials and instruct each one to construct a complete circuit that includes a light bulb. Ask students to draw and describe their circuit configuration in their notebooks and use a colored line and arrows to note the pathway of electrical energy through the entire circuit, including the light bulb. Suggest that a cut-away drawing would show the pathway electrical energy takes through the circuit. It may be helpful for students to trace the circuit path with their fingers. Students may need to see an example of a cut-away drawing and discuss their characteristics, if they are not familiar with them.

6 Discuss circuits as systems.

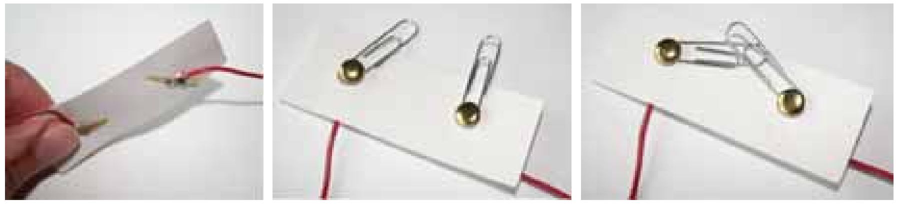
Engage in a discussion about the individual parts making up the circuit and how the individual parts of the circuit work together to perform the task of lighting a bulb. During the discussion, students should refer to the sketches and descriptions in their scientists' notebooks. Ask students to give specific examples of what might happen if certain parts of the circuit were missing, broken, worn out, misconnected, or mismatched. For example, students might say that the bulb might not light because the wires were not properly connected to the critical contact points on the bulb, the battery was dead, the bulb was blown, or there wasn't enough power in the battery to light the bulb, etc. Emphasis during this discussion should be that many parts of a circuit work together to accomplish a task, in this case lighting a bulb. If one part of the circuit is not functional, the bulb will not light.

7 Introduce the switch.

Ask students how they initiated the flow of electrical energy through the circuit:

- *How do we turn the light bulb on and off?* (By connecting and disconnecting the wires from the battery and/or the bulb. Demonstrate this action as it is being discussed.)
- *How is this like the way we turn the flashlight or our lights at home on and off?* (Switches are used to turn flashlights and lights on and off at home.)

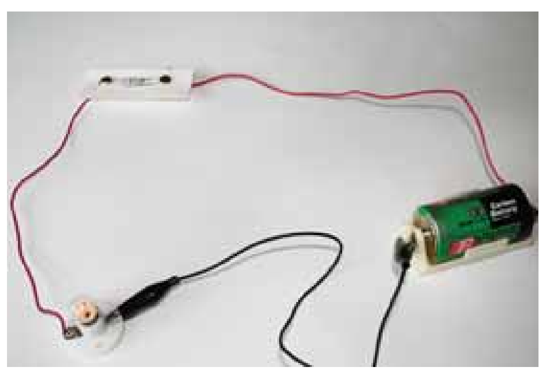
Demonstrate how to make a simple switch using an index card, brass fasteners, and a paper clip. Instruct each student team to make one. Students integrate the switch into their circuits and use the switch to control the flow of electricity to the bulb. They draw the circuit showing the switch operating in two ways: closing the circuit (lighting the bulb) and opening the circuit (not lighting the bulb).



Hold up the following prefabricated components: a switch, battery and bulb holder, and bulb. Ask students to share their ideas as to what these items might be used for. Explain to students that the bulb and battery holder help to hold the parts of the circuit more securely in place. Show students how to integrate these components into a complete circuit, pointing out the critical contact points of the battery and bulb holder and the switch. Allow students a few minutes to create a circuit using these new components and instruct students to make a cut-away sketch of a complete circuit that clearly shows the pathway of electrical energy includes the new components.

8 Revisit electrical energy pathways (complete circuits).

Direct students to discuss in small groups at their tables their understanding of the specific pathway electrical energy takes in the circuit they've constructed that includes the prefabricated components. As students are discussing their circuit configuration note what they are finding. Students may notice that their classmates have integrated the components in slightly different ways.



Note: *Some students may hold naïve ideas about how the circuit works even after building one successfully. They may think that each wire brings electrical energy from the battery up to the light bulb rather than electrical energy traveling in one direction through the wire "loop." Or they may think one wire is active and one is not. Use their thinking to guide your questioning and discussion.*

9 Discuss parts and wholes connection.

Revisit the idea of systems (parts and wholes) focusing on the additional components (bulb and battery holder and switch) by engaging in a brief discussion similar to the earlier conversations about the relationship(s) between the individual parts making up the circuit and the overall system's task. Encourage students to refer to the sketches and descriptions in their notebooks during the discussion. As before, ask students to provide specific examples of what might happen if certain parts of the circuit were missing, broken, worn out, misconnected, or mismatched. Ask students how the circuit has changed. (It has gotten more complex.)

Reflect And Discuss

10 Facilitate discussion of light findings.

Refer back to the *Early Light* cards and the *Light Cards* students created by examining lights found in their homes and communities in Lesson 1. Show students a simple desk lamp and ask: *What parts do these lamps have in common with lamps found at home?* Students may identify the individual parts of the lamp such as the bulb, bulb holder, wire cord, and switch. Support this exercise with either a cut away diagram of a lamp showing critical parts that students could draw or place in their notebooks and/or by labeling the parts of the lamp with the word as it is identified. If the idea that the lamp needs to be connected to a power source to be a complete circuit doesn't surface, pose the question to students: *How can a lamp be considered a complete circuit? How do the individual parts of the lamp work together to provide a pathway for electrical energy?* Conversely, give an example of a part that could be missing, not working, or connected improperly, and describe how this affects the circuit.

Explain and use the Teacher Resource 3.2 showing that lamp cords are actually two bundles of wire: one wire provides a pathway for electrical energy to go toward the lamp and one carries electrical energy/electricity away from the lamp.

During this discussion, students may notice that the wires and cords have a plastic coating on them. If they do not, call attention to this detail by asking students why they think the wires might be covered with plastic. This question sets the stage for Lesson 4, which introduces insulators and conductors.

11 Bring lesson to a close.

Bring the lesson to a close by asking students to complete the prompt on Student Handout 3.1: The Light Bulb Problem. Collect, review, and summarize these prompts prior to Lesson 4.

Home-School Connection

Light Bulb Survey.

Guide students through a process for conducting a light bulb survey in their homes. Suggest using a tally system or simple data table to count and record the number of bulbs in their homes. This should include categorizing light bulbs by type. Ex: incandescent, compact florescent, florescent, LED, halogen, etc. The survey could be extended in a number of ways:

• Create a class tally chart.

• Calculate the percentages of each type of bulb used.

• Graph the different wattage of the various bulbs used.

> **Note:** *In Lesson 8, students compare the amount of energy, heat, bulb life, and light output for various light bulb types. Previewing this lesson may help to determining how extensively to investigate bulbs at this point.*

Planning Ahead

Collect, review, and summarize student responses from Student Handout 3.1 prior to Lesson 4. Select responses that describe how Addison should connect the various components of the circuit, in particular those that mention the role of the key parts of the light bulb or address specific parts-wholes ideas.

Extensions

Student may:

- investigate early light bulbs, making note of materials used to make filaments and considering the following questions:
  Why were these materials selected?
  What properties do these materials have?
- examine various types of switches.
- research the work of Thomas Edison and the many other contributors to the development of the incandescent light bulb.
- read Doolinrg, M. (2005). *Young Thomas Edison*. New York: Holiday House.
- read deMauro, L. (2005). *Time for kids: Thomas Edison: A brilliant inventor*. New York: Harper Collins.
- create a the timeline of inventions contributing to the invention of the light bulb.

Connection to Maine Agencies

MEEP (Maine Energy Education Program) has Home Lighting Inventory and will come to interested schools, free of charge. Students take an inventory of the lighting in their homes – number of fixtures, types of bulbs, and how long the lights are used per day – to see what impact lighting has on their electricity consumption. The MEEP website is http://www.meepnews.org/classroom activities

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a visit contact Nancy Chandler at207.760.2556 or nchandler@mainepublic service.com

Online References and Resources

Additional background on electric circuits:

http://www.teachersdomain.org/resources/phy03/sci/phys/mfe/lp_electric/index.html

Edison's early light bulb collection that served as evidence in legal battles around patents of the incandescent light bulb. The collection includes images and descriptions of the various prototypes Edison developed. http://www.edisonian.com/

Sites that provide insight into the historical timeline and inventors of the light bulb:

Edison National Historic Site:
http://www.nps.gov/edis/home.htm

Lemelson Center for the Study of Innovation and Invention:
http://invention.smithsonian.org/centerpieces/edison/

Thomas A. Edison Papers:
http://edison.rutgers.edu/

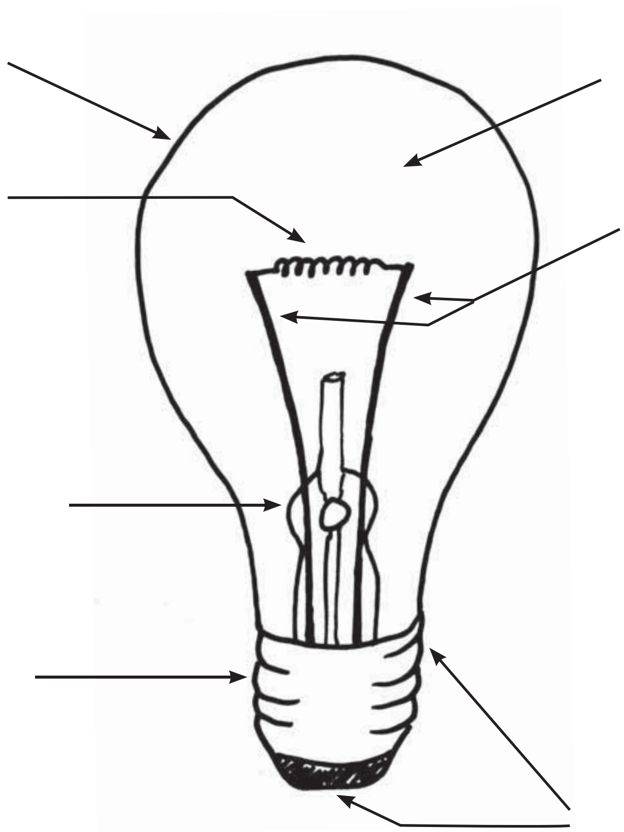
The Light Bulb Problem

Your friend Addison has just finished putting a simple circuit together using a battery, bulb, switch, and wire. After completing the circuit, the bulb does not light.

☞ What are two things you would suggest to Addison to try to figure out why the bulb did not light?

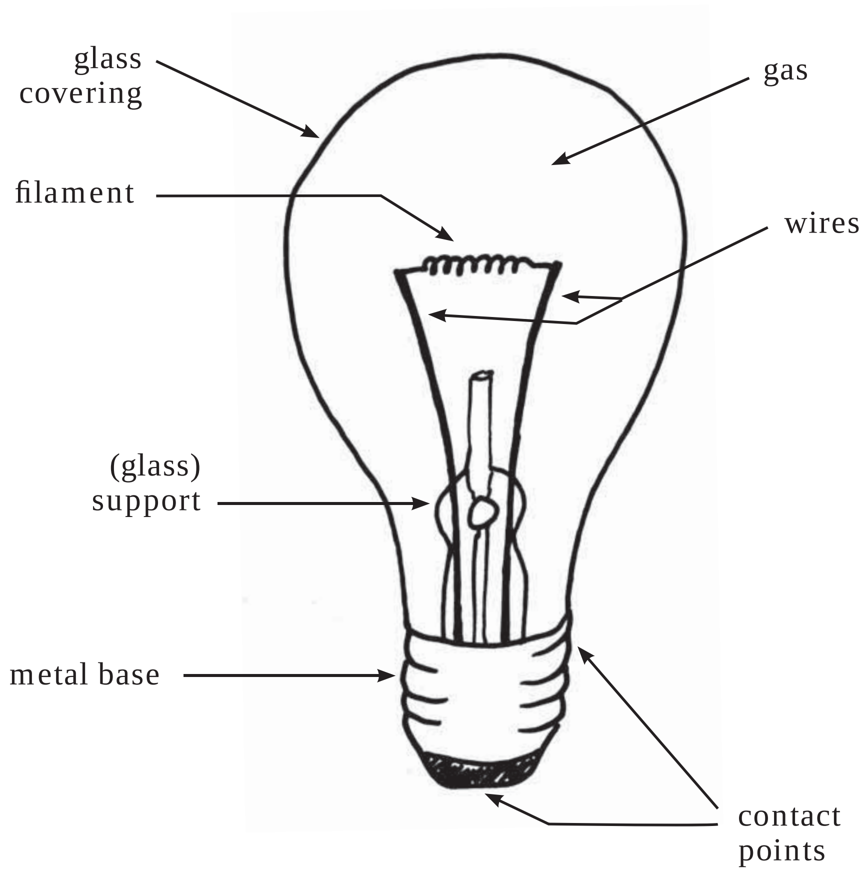
Use words and pictures – sketches, diagrams, drawings – to explain your thinking.

Incandescent Light Bulb



- filament
- glass covering
- wires
- metal base
- (glass) support
- gas
- contact points

Incandescent Light Bulb Key



Desk Lamp