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Lesson Focus

Lesson focuses on the concept of electron flow through the demonstration of electrical circuits in a flashlight, and how batteries operate.

Lesson Synopsis

The Flashlights and Batteries activity explores how a flashlight works, showing the electric circuit and switch functions of this everyday household item. Students learn how batteries work, how they provide power to the simple circuit within a simple flashlight, and how the switch controls the flow of electrons. Students disassemble a flashlight, and draw a schematic of a flashlight's circuit design.

Age Levels

8-11.

Objectives

- ✦ Learn how switches control the flow of electricity.
 - ✦ Learn to draw basic electric schematic diagrams.
 - ✦ Learn how the electric circuit and battery within a flashlight operates.
 - ✦ Learn about teamwork and working in groups.
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Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- ✦ batteries
 - ✦ switches
 - ✦ circuits and current
 - ✦ basic electrical schematic diagrams
 - ✦ teamwork
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Lesson Activities

Students learn how batteries work, and explore the simple circuit system found in a standard flashlight. Topics examined include batteries, electron flow, switches, and bulbs. Students disassemble a flashlight and also document their findings by creating schematics of flashlight electric circuits.

Resources/Materials

- ✦ Teacher Resource Documents (attached)
- ✦ Student Worksheets (attached)
- ✦ Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ TryEngineering (www.tryengineering.org)
- ✦ IEEE Global History Network - Batteries (www.ieeeahn.org/wiki/index.php/Batteries)
- ✦ ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- ✦ National Science Education Standards (www.nsta.org/publications/nses.aspx)

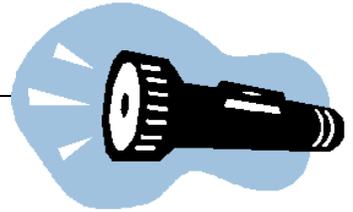
Recommended Reading

- ✦ DK Eyewitness Series: Electricity (ISBN: 0751361321)
- ✦ Eyewitness Electricity, by Steve Parker (DK Publishing, ISBN: 0789455773)
- ✦ How Science Works, by Judith Hann (Readers Digest, ISBN: 0762102497)
- ✦ The Usborne Book of Batteries & Magnets (How to Make Series), by Paula Borton, Vicky Cave (E D C Publications, ISBN: 074602083X)

Optional Writing Activity

- ✦ Write an essay or a paragraph describing how crank flashlights operate.

Flashlights and Batteries



For Teachers: Teacher Resources

◆ Lesson Goal

Explore simple circuits by demonstrating how batteries and flashlights operate. Students disassemble a flashlight, learn about the circuit design, and create schematics of flashlight electric circuits.

◆ Lesson Objectives

- ★ Students learn how switches control the flow of electricity.
- ★ Students learn to draw basic electric schematic diagrams.
- ★ Students learn how the electric circuit and battery within a flashlight operates.
- ★ Students learn about teamwork and working in groups.

◆ Materials

- Student Resource Sheet
- Student Worksheet
- One set of materials for each group of students:
 - Flashlight
 - 2 D Batteries
 - Two switches
 - Paper
 - Pencils



◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 3-4 students, providing one set of materials per group.
3. Show students a working flashlight and explain how the switch on the flashlight controls the flow of electricity throughout the flashlight circuit.
4. Ask the students to disassemble and reassemble the flashlight, so that it operates.
5. Ask students to draw in the Student Worksheet an electric circuit schematic for a flashlight in the "on" position.
6. Student groups next design an improved flashlight, and draw another electronic schematic for their new design. (Ideas: new materials, multiple bulbs, extra batteries)
7. Each student group presents their design to the class after designing on paper.

◆ Safety Note!

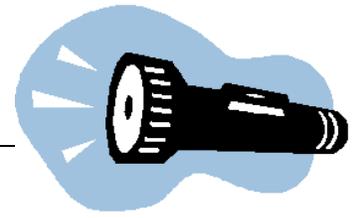
Be sure students do not try to disassemble a battery.



◆ Time Needed

One to two 45 minute sessions

Flashlights and Batteries

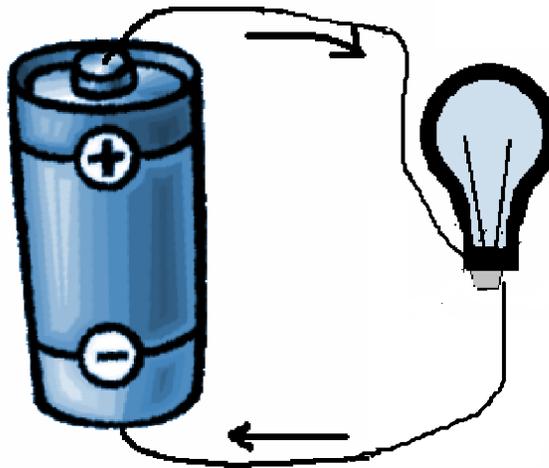


Student Resource: What is a Simple Circuit?

◆ Simple Circuit

A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: a source of electricity (battery), a path or conductor on which electricity flows (wire) and an electrical resistor (lamp) which is any device that requires electricity to operate. The illustration below shows a simple circuit containing, one battery, two wires, and a bulb. The flow of electricity is from the high potential (+) terminal of the battery through the bulb (lighting it up), and back to the negative (-) terminal, in a continual flow.

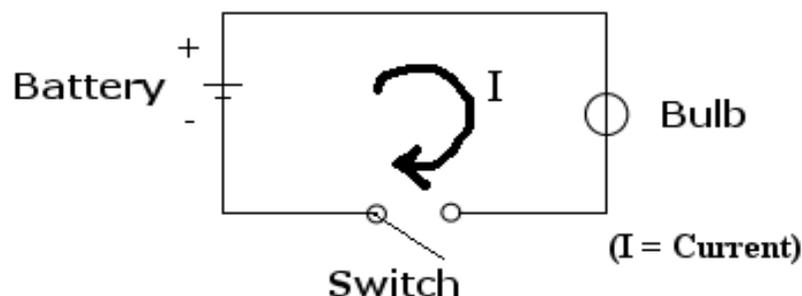
Simple Circuit



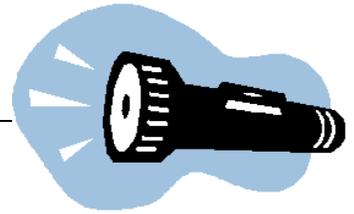
◆ Schematic Diagram of a Simple Circuit

The following is a schematic diagram of the simple circuit showing the electronic symbols for the battery, switch, and bulb.

Schematic Diagram of a Simple Circuit

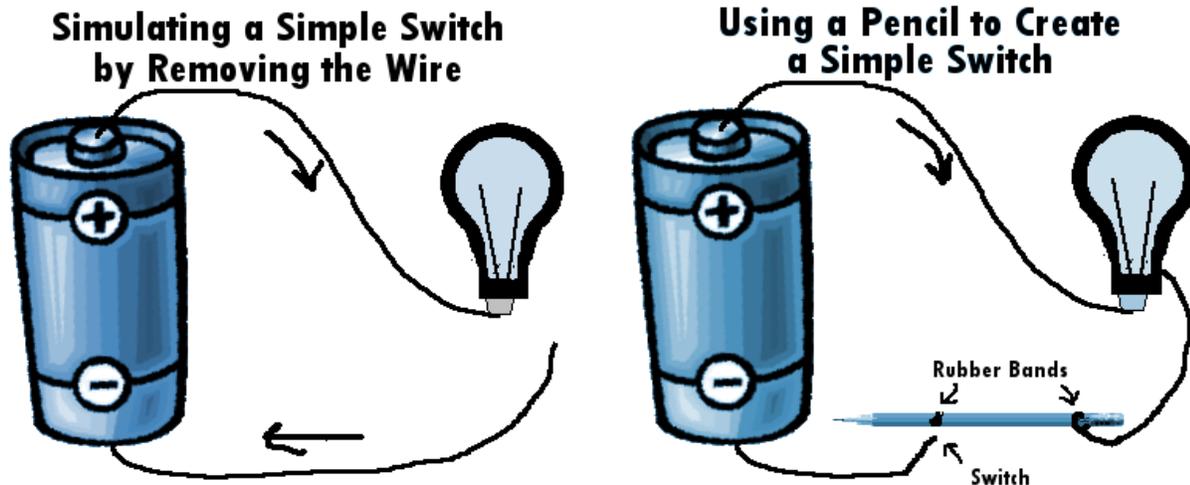


Flashlights and Batteries



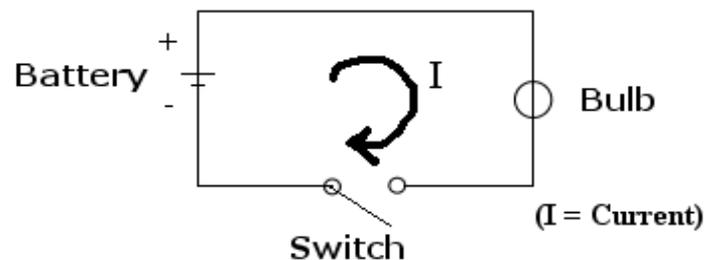
Student Resource: Simulating a Switch

◆ Simulating a Switch by Disconnecting a Wire or Adding a Pencil

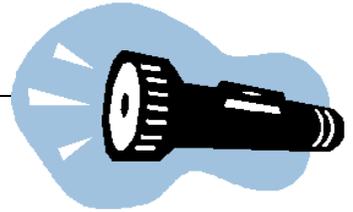


There are several ways you can simulate a switch in a simple circuit. Simply removing and replacing the wire from the bulb can serve as a switch. Another simple switch can be made by attaching the end of one of the wires to the eraser end of a pencil using a rubber band. Then attach another rubber band to the other end of the pencil, and by simply laying the other end on top of - and then off of - the connecting wire, you have created a switch. Other types of conductors can also be used in switch design, such as aluminum foil, hairclips, paperclips, paper fasteners, and some metal pens.

Schematic Diagram of a Simple Circuit



Flashlights and Batteries



Student Resource: Battery Basics

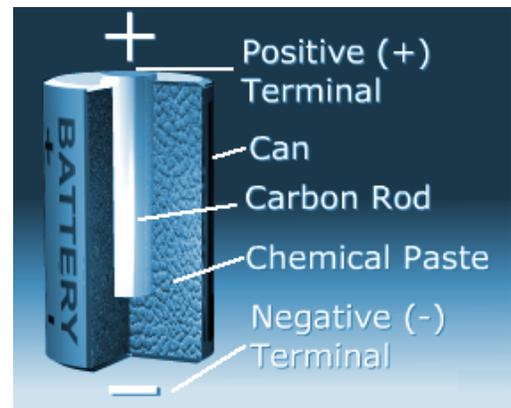
◆ Battery History



The first battery was demonstrated in 1800 by Count Alessandro Volta. His experiments showed that different metals in contact with each other could create electricity. He constructed a stack of discs of zinc alternating with blotting paper soaked in saltwater and silver or copper. When wires made of two different metals were attached to both the top and bottom discs, Volta was able to measure a voltage and a current. He also discovered that the higher the pile, the higher the voltage. The current is produced because of a chemical reaction arising from the different electron-attracting capabilities of the two metals. This device became known as a 'voltaic pile' (the French word for 'battery' is 'pile'). Although they were large and bulky, voltaic piles provided the only practical source of electricity in the early 19th century.

◆ How Batteries Work

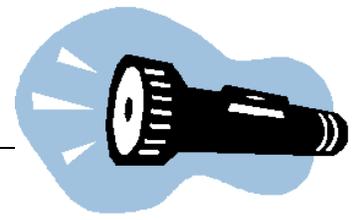
The pile or battery remained a laboratory curiosity for years, until the newly invented telegraph and telephone created a demand for reliable electrical power. After many years of experimentation, the "dry cell" battery was invented in the 1860s for use with the telegraph. The dry cell is not completely dry, however. It holds a moist paste inside a zinc container. The interaction of the paste and the zinc creates a source of electrons. A carbon rod is inserted into the paste and conducts electrons to the outside of the cell, where wires or metal contacts carry the electrons that power the device. A single dry cell produces about 1.5 volts.



◆ Extension

Additional information on battery history may be found on the IEEE Global History Network (<http://www.ieeeahn.org/wiki/index.php/Batteries>).

Flashlights and Batteries

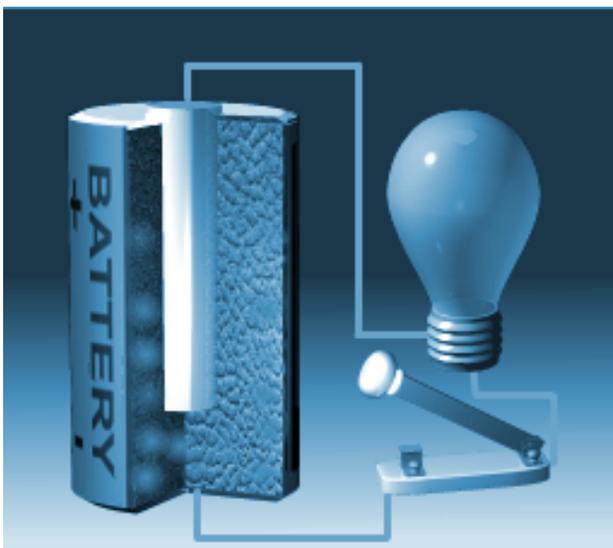


Student Resource: Battery Basics

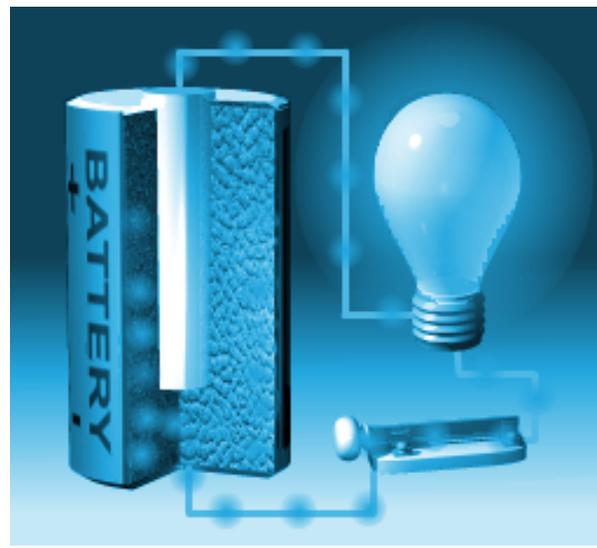
◆ The Flow of Electrons

After many years of experimentation, the "dry cell" battery was invented in the 1860s for use with the telegraph. The dry cell is not completely dry, but holds a moist paste inside a zinc container. The interaction of the paste and the zinc creates a source of electrons. A carbon rod is inserted into the paste and conducts electrons to the outside of the cell, where wires or metal contacts carry the electrons that power the device. A single dry cell produces about 1.5 volts. Dry cells can be stacked inside a single container to produce batteries with other voltages. The small 9-volt batteries used today are a good example of this.

The bottom terminal is called the "negative" terminal. The top terminal is called the "positive" terminal. When a circuit connects the positive and negative terminals, the free electrons at the negative terminal flow towards the positive terminal. The flow of electrons is called an electric current, but engineers define the current as moving from the positive terminal to the negative terminal, the opposite of the actual flow of electrons. This is because current was defined before scientists knew that the charge on an electron is negative. Electrons are the particles that carry the electric current. In the example to the left below, a switch connecting the battery to a bulb is in the "off" position, so the bulb is dark. On the right, the switch is in the "on" position, allowing the flow of electrons to light up the bulb.



Switch in "Off" Position
(Source: IEEE Virtual Museum)

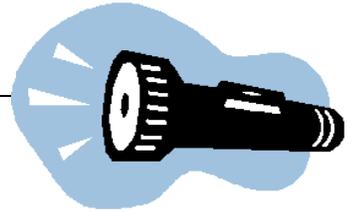


Switch in "On" Position
(Source: IEEE Virtual Museum)

◆ Extension

Additional information may be found on the IEEE Global History Network (www.ieeeahn.org).

Flashlights and Batteries



Student Resource: Flashlight Basics

◆ Flashlight History

In the 1890s, American Ever-Ready Company founder Conrad Hubert invented the electric hand torch. Hubert acquired the patent for the first Eveready flashlight in 1898. Hubert's first flashlights were made from paper and fiber tubes, with a bulb and a brass reflector. At the time, batteries were very weak and bulbs were still developing, so the first flashlights produced only a brief "flash" of light - which gave the invention its name.

◆ How Flashlights Work

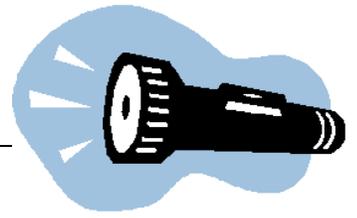
There are seven main components to a flashlight:

- ✦ Case or Tube: holds all the other components of the flashlight.
- ✦ Contacts: thin spring or strip of metal usually made of copper or brass that serves as the connection between the battery, lamp, and switch.
- ✦ Switch: can be in on or off position.
- ✦ Reflector: plastic coated with a reflective aluminum layer to help brighten the effective light of the bulb.
- ✦ Bulb: usually very small.
- ✦ Lens: plastic cover in front of the bulb to protect the lamp which could easily be broken.
- ✦ Batteries: Provide power to the flashlight.



When the switch is in the "on" position, it connects the two contract strips which allow electrons to flow. The batteries provide power to the flashlight, and sit on top of a small spring that is connected to one of the contact strips. This contact strip runs along the length of the case and contacts the switch. Another contact strip connects the switch with the bulb. Finally, another contact connects the bulb to the top battery, completing the circuit.

Flashlights and Batteries

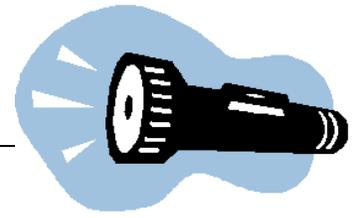


Student Worksheet:

- ◆ Draw a schematic diagram of the circuit design for the standard flashlight in the "on" position in the box below.

- ◆ Draw the schematic diagram for your improved flashlight in the box below.

Flashlights and Batteries



For Teachers: Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (<http://www.nextgenscience.org/>)
- International Technology Education Association's Standards for Technological Literacy (<http://www.iteea.org/TAA/PDFs/xstnd.pdf>)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (<http://www.nctm.org/standards/content.aspx?id=16909>)
- U.S. Common Core State Standards for Mathematics (<http://www.corestandards.org/Math>)
- Computer Science Teachers Association K-12 Computer Science Standards (<http://csta.acm.org/Curriculum/sub/K12Standards.html>)

◆ National Science Education Standards Grades K-4 (ages 4 - 9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ✦ Light, heat, electricity, and magnetism

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Understanding about science and technology

◆ National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ✦ Transfer of energy

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Understandings about science and technology

◆ Next Generation Science Standards – Grades 3-5 (Ages 8-11)

Energy

Students who demonstrate understanding can:

- ✦ 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

◆ Standards for Technological Literacy - All Ages

Design

- ✦ Standard 8: Students will develop an understanding of the attributes of design.
- ✦ Standard 9: Students will develop an understanding of engineering design.
- ✦ Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.