WV EXTENSION | 4-H

extension.wvu.edu

DO IT YOURSELF FLASHLIGHT

A WVU Extension STEMCARE Lesson

Audience:

Grades 4-12

Time:

60 minutes

(15 minutes to review the engineering design process and light, and introduce circuits; 15 minutes to watch WVU STEMCARE DIY Flashlight demonstration; 10-15 minutes to build and test the flashlight; 15-20 minutes to reflect and redesign)

Materials:

For each student: 2 strips of copper tape; LED; large craft stick; jumbo paperclip; CR2032 coin battery; masking tape; scissors; paper and pencil

Optional materials for Taking it Further: Concave and convex lenses; binder clips or other alternative switches; aluminum foil or other reflective material; diffusers (wax paper, transparent colored report covers or gel diffusers); assortment of LEDs

Vocabulary:

Circuit, current, electricity, LED, chemical potential energy, kinetic energy, load, semiconductor, medium, battery

Goal:

Develop an understanding of the relationship between electricity and light in a simple LED circuit. Use the engineering design process to improve a working flashlight.

Introductory Activity

1. Review the engineering design process, chemical potential energy and kinetic energy. Show students a flashlight and ask students to record their thoughts on where the energy is coming from and how it works.
2. Show the WVU STEMCARE DIY Flashlight video *(https://youtu.be/5y4kXqYkVos).*
3. Explain that light emitting diodes (LEDs) are semiconductors that emit light as current flows in a single direction through them (Figure 1). A simple circuit can be created by using an electrochemical battery as a power source. The current flows along the medium and will only stop flowing if the connection to the medium is broken.
4. Challenge students to make a working LED flashlight that can turn on and off using copper tape as the medium and a coin cell battery as the power source.

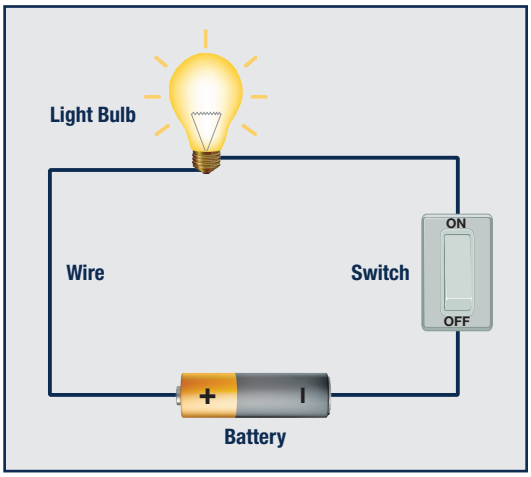

Figure 1. A simple circuit.

Core Learning Activity: Building a Working Flashlight

Students will create their own prototype flashlight, and modify and improve their design.

Build a Flashlight

1. Run a strip of copper foil tape down one side of the craft stick.
   Tip: Remove the adhesive backing a few centimeters at a time as you press the copper tape in place.

— continued —

STEMCARE
TURNING POSSIBILITIES INTO OPPORTUNITIES

2. Flip the craft stick over and run a second strip of copper foil down that side. The two pieces should not be touching.
3. Open a jumbo paperclip just enough to make a V. Place the battery down on the copper tape on one side with the negative (–) side down touching the foil tape. Place the large end of the jumbo paperclip down touching the copper tape on the opposite side of the stick.
4. Tape over both the large end of the jumbo paperclip and the battery with masking tape. *NOTE: Be sure not to completely cover the battery with masking tape. There needs to be an exposed area for the other end of the paperclip to touch. This will act as your switch.*
5. Place the LED on the end of the craft stick opposite the paperclip and battery (Figure 2). The long leg (positive lead) should straddle the side of the craft stick opposite the battery. Both legs should be touching the foil tape on each side of the craft stick.

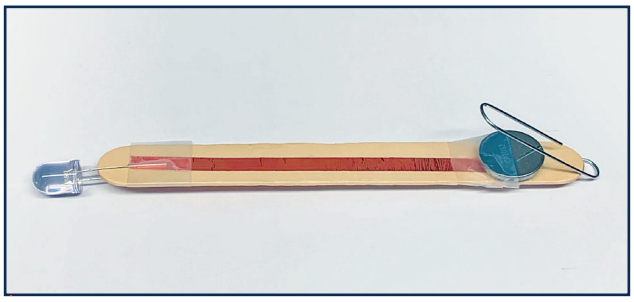

Figure 2. Completed DIY flashlight.

6. Test by pushing the paperclip down so that it touches the battery (Figure 3). The LED should light up. If it's working, tape the legs of the LED down with the masking tape.

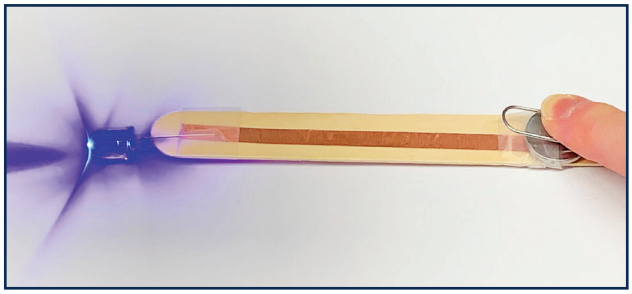

Figure 3. Testing the flashlight.

7. Now you have a simple flashlight with a switch. To turn it on, hold the paperclip down with your thumb so that it touches the battery.

Safety Precautions

Adult supervision is required for this activity as coin cell batteries can be a choking hazard. Tell students **never** to experiment with electricity from a wall outlet because it can be fatal.

Background: The Science Behind DIY Flashlights

- The flashlight you made today is an example of a simple direct current (DC) circuit. Simple circuits include a power source, a conducting medium (like a wire) and a load. In your simple circuit, the power source is the coin cell battery, the conducting medium is the copper tape and the load is the LED.
- The battery in your flashlight serves as the source of energy that makes the light turn on. When you turn on your flashlight, chemical reactions occur inside the battery creating a flow of electrons. In the process, stored chemical energy in the battery (potential energy) is converted into electrical energy (kinetic energy) to power the LED.
- Current is the flow of electrons in a circuit. Voltage is the force that causes the electrons to flow.
- Your flashlight also includes a switch, which is used to alter the flow of electrons in a circuit. In an open circuit (switch in the "off" position), the flow of electrons is blocked, and no light is emitted. When a circuit is closed (switch in the "on" position), the electron flow is unblocked, and light is emitted (Figure 4).

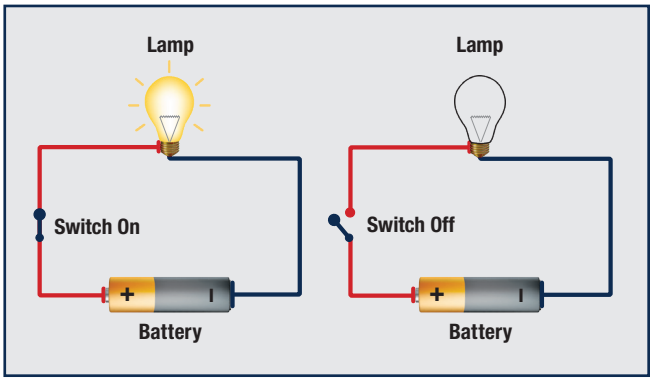

Figure 4. A closed circuit allows the current to flow to the light. An open circuit interrupts the current and the light is off.

- LEDs are like a one-way street because they only allow electrons to flow in one direction. This is why the position of the battery relative to the LED is important. It will only emit light if correctly positioned.

— continued —

Taking it Further

Challenge students to use the optional materials and the engineering design process to redesign, build and test one aspect of their flashlight to make it more useful to them (Figure 5). Conduct tests of the criteria chosen. Options could include altering the light beam or creating a better switch.

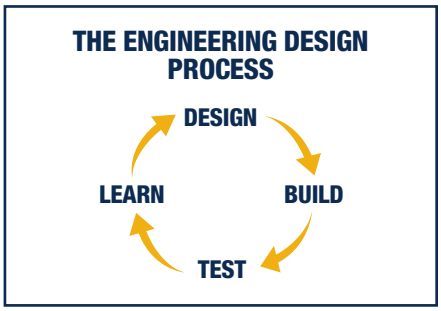

Figure 5. The engineering design process. (Source: http://www.thunderboltkids.co.za/Grade5/03-energy-and-change/chapter3.html)

Resources

Activity adapted from: *Flat Flashlight,* Oakland Discovery Center Blogspot: Accessed November 11, *https://oaklanddiscovery.blogspot.com/2012/10/flat-flashlight.html.*

West Virginia College- and Career-Readiness Standards for Science

Science

- S.4.2 Students will make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- S.4.4 Students will apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*
- S.PS.17 Students will design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*

Standards followed by an asterisk (*) denote the integration of traditional science content with an engineering practice.

Engineering, Technology, and Application of Science

- S.3.16, S.4.14, S.5.15 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- S.3.17, S.4.15, S.5.16 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- S.3.18, S.4.16, S.5.17 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- S.6.20 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution.
- S.6.21 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each.
- S.7.22 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, considering limitations to solutions including scientific principles and potential relevant possible impacts on people and the environment.
- S.7.23 Analyze data from tests to determine which characteristics of design can be combined into a new solution to better meet the criteria for success.
- S.8.18 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- S.8.19 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- S.P.34, S.PS.31 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

WVU STEMCARE DIY Flashlight Demonstration Video: https://youtu.be/5y4kXqYkVos

4H21-109