TEACHERS GUIDE

MINIATURE LED LIGHTS
ITEM # 4007-37

ENERGY - ELECTRICITY

Upgrade your outdated bulbs to the 21st century!
These miniature LED lights will replace all your old mini incandescent bulbs and are far more energy efficient with an average lifespan of 50X the life of a regular bulb. Perfect for use with a variety of electricity and other science projects, for example in circuits.

Materials

- batteries
- wire
- alligator clips
- battery holders
- miniature bulb holders
- miniature incandescent bulbs
- additional circuitry lab materials (optional)

Goals & Objectives

See page 7 for Next Generation Science Standards (NGSS)

INTRODUCTION

Light Emitting Diodes, or LEDs, are semiconductors that emit energy in the form of photons of light. Compared to incandescent bulbs in which electric current causes a metal filament to heat enough to give off light (about 2,200 degrees C), LED bulbs are far more energy efficient. Use these LED bulbs as you would incandescent miniature bulbs in your classroom, home, or office.

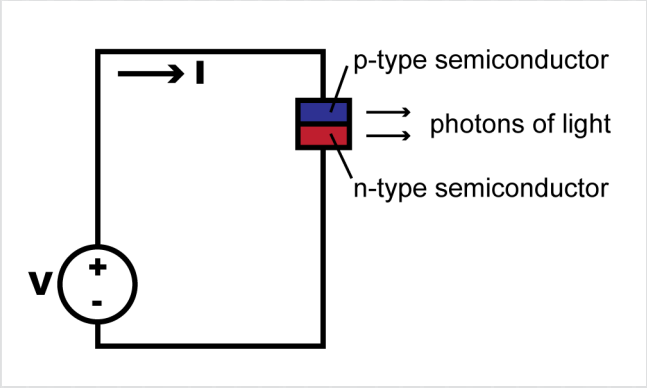
In addition to being a practical and economical alternative to incandescent bulbs, these miniature LED lights are sturdy enough for student use in hands-on labs, and can be used to explore the nature of electricity, circuits, energy transfer, and diodes.

How It Works

An LED is a semiconductor device made of two types of semiconductor materials. The p-type material acts as the anode and contains positively charged carriers, or holes. The n-type material acts as a cathode and contains negatively charged carriers, or electrons. Placed together these two semiconductor materials form what is known as a p-n junction diode. When placed in a circuit with an energy supply, such as a battery, negatively charged electrons move towards the positive holes. As electrons combine with holes they move down to a lower energy level and energy is released in the form of photons of light. This process is known as electroluminescence.

The p-type and n-type materials are created by “doping” a semiconducting material with impurities that contain the negative and positive charges. Different impurities result in varying amounts of energy being released. The wavelengths (and color) of the light depends upon the energy difference, or band gap, between the electrons and the holes caused by different doping materials. The range of wavelengths of light that can be emitted by electroluminescence ranges from infrared to ultraviolet on the light spectrum.

Due to the polarity of the p-n junction, LED semiconductors can only function when current flows in one direction. Reversing the flow of the current results in no light and can, in some cases, damage the diode.



ACTIVITIES

1. For the youngest of students, LED bulbs can be used simply as light sources to explore light, illumination, and vision. Guide students to make observations, conduct investigations, and design/engineer devices to meet the needs of learning content and standards.

2. Circuit Exploration – Use the Miniature LED Lights in your own circuit labs or try a few of the following ideas to introduce and expand upon the concepts of electrical circuitry.

    - Introduce simple circuits by challenging students to light a single bulb using only a battery and a length of wire with an alligator clip at each end. Encourage students to try different configurations even if they have figured out one way to light the bulb. Have students try reversing the direction of the battery after developing a configuration that works.

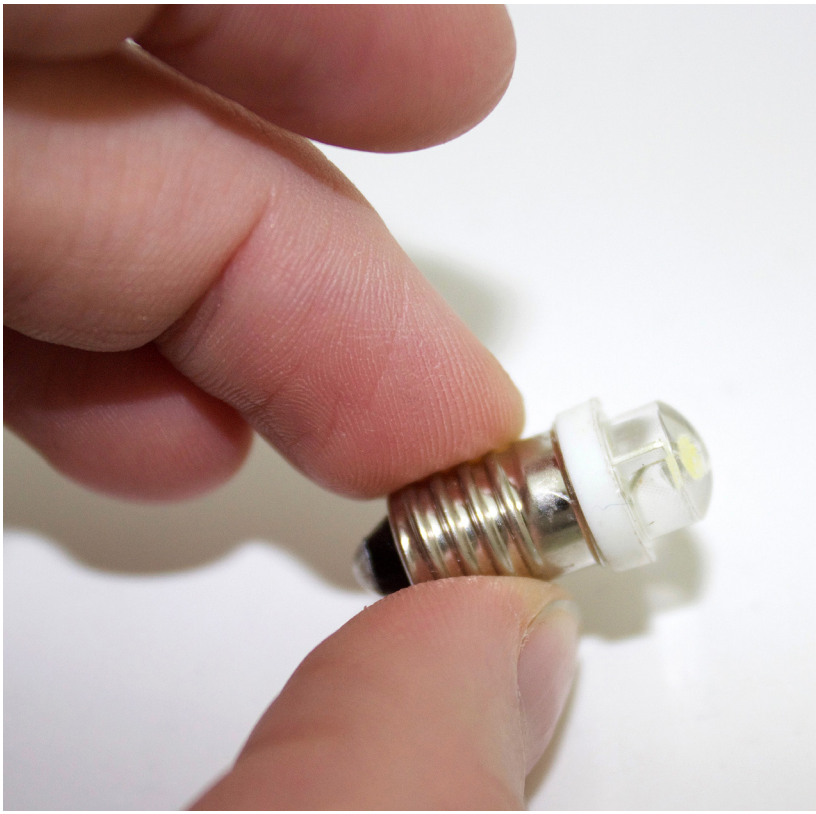
    - Continue exploration by introducing additional materials such more batteries, more bulbs, and wires of various lengths. Bulb holders, battery holders and additional circuitry lab materials can expand the learning. Can students get more than one bulb to light on the same circuit? What happens to the light when additional batteries are added into the circuit? Do results vary depending upon the configuration of the circuit (series vs. parallel)? Use their experimentation and learning to introduce the concepts of series and parallel circuits or test their understanding of circuits by challenging students to create various configurations or engineer a product that meets a particular challenge.

3. Compare LED bulb to incandescent bulbs – Include incandescent bulbs alongside the LED bulbs in your circuit lab activities. Encourage students to explore the similarities and differences between the two kinds of bulbs. Challenge students to plan and carry out an investigation or experiment that compares the two kinds of bulbs collecting both quantitative and qualitative data.

4. Engineering Challenge – Challenge students to use the LEDs to design a tool or product that meets a specific need or set of parameters. Have student groups compare their different designs qualitatively and quantitatively to determine the best design(s).

***Note**

It is always wise to DO an experiment ahead of time to be able to best present it to the class.



DISCUSSION

Additional Discussion and Real Life Applications

1. Where have you seen LEDs in use?
   What are the benefits and drawbacks of using LEDs in different forms of technology?

2. Discuss the differences and similarities between LED bulbs and traditional incandescent bulbs. What are the benefits and drawbacks of each?

3. Describe the transfers and transformations of energy in a circuit that includes an LED bulb. Do the same for an incandescent bulb.

4. Why do LEDs only emit light when electric current flows in one direction, but not in reverse? Create a diagram or model to explain your answer.

GLOSSARY

Vocabulary and scientific concepts:

- circuit
- conductor
- current
- diode
- electrons
- holes
- parallel circuit
- p-n junction
- polarity
- resister
- semiconductor
- series circuit
- voltage

Next Generation Science Standards

Students who demonstrate understanding can:

1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.

1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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

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

Standards Key

K = Kindergarten
3 = 3rd Grade
(numbered by grade)
MS = Middle School
HS = High School
PS = Physical Science
LS = Life Science
ES = Earth Science
ETS = Engineering, Technology and the Application of Science

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-4. 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.

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy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