

Name:

Class:

ACTIVITY 1

Exploring LEDs and Lamps

Goal

In this activity, you will explore the effect of changing the energy supplied to incandescent lamps and light emitting diodes, then look for similarities and differences among the different light sources.

Matter emits light through various processes that transform other forms of energy into light. For example, a flame from a candle or fireplace during the burning process emits light. The incandescent lamp — a light bulb — is a standard light source that is recognizable by its characteristic shape and appearance. The light bulb contains a solid tungsten filament that emits light when energy is provided by an external energy source such as a battery or electrical power plant.

? Examine the incandescent lamp that you have been provided. Draw the location of the filament and wires inside the lamp.

Voltage is a measure of energy being supplied to an electrical device like an incandescent lamp. Although household incandescent lamps typically require a high voltage to operate, incandescent lamps such as the one that you have been supplied operate with low voltages from a battery.

Another modern light source that requires low voltages is the light emitting diode (LED). LEDs are typically used as on/off indicator lights in electrical appliances such as televisions, VCR's, video cameras, computers, and stereos. They are also used to display numbers in some alarm clocks, radios, and microwave ovens. Another use is very large video displays at sporting events and concerts. For example, the music group *U2* during its 1997 *POPMART* tour was using a 56 feet x 170 feet video screen consisting of LEDs. In the 1997 movie, *Batman & Robin*, the Mr. Freeze costume worn by Arnold Schwarzenegger consisted of 3,800 blue LEDs to illuminate his appearance. The low voltage requirements needed to operate LEDs as well as their small size and mass make them an attractive light source to use for these applications.

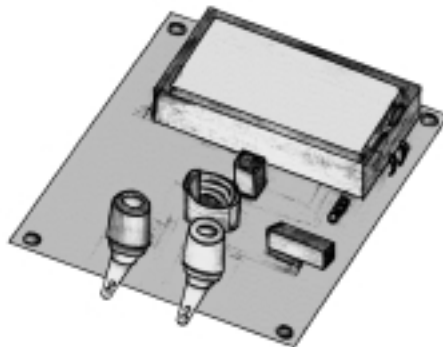
A diagram of the inside of an LED is shown in Figure 1-1. The chip at the heart of the LED consists of two different solid materials that have been joined together. It is surrounded by a transparent, hard plastic that protects the LED from vibration and shock. The LED is constructed in such a way that the light emitted by the chip is reflected off the base it sits on and is focused through the top of the LED. Thus, the light is brightest at the top of LEDs.



Figure 1-1: Schematic Diagram of an LED

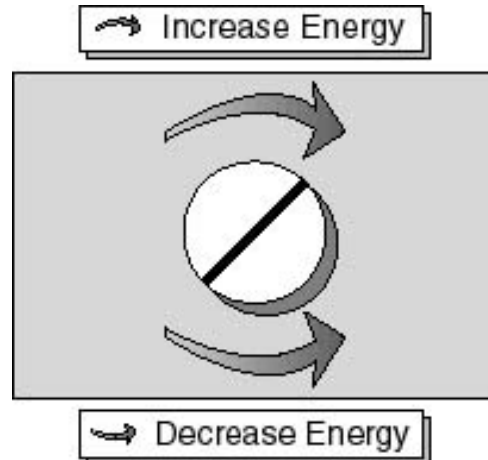
Examine the LEDs that you have been provided. Notice that the two connecting wires have different lengths. These connecting wires are connected to the chip by very thin wires inside the LED.

In this first activity, we will connect lamps and LEDs individually to an electrical energy source and investigate the effects of changing the amount of electrical energy supplied to them. The apparatus uses a small battery as an energy source. The amount of energy reaching the lamp or LED is controlled by a potentiometer — a small rectangular device with a screw on one end. Turning this screw changes the energy going to the lamp or LED in the sockets. The apparatus used for these measurements are shown below.



Check the apparatus by inserting the incandescent lamp in its socket and connect the battery to the battery clips. Adjust the meter in the circuit so that it will have a range of about 0 - 9 Volts, and it will measure voltage. The incandescent lamp should come on and the meter displays the voltage. If not, turn the screw on the potentiometer in the counterclockwise direction until the light comes on. If the lamp still does not emit light, check the connections or ask the instructor to help.

To vary the energy supplied to the incandescent lamp turn the knob of the potentiometer by using the tiny screwdriver. Either end of this screwdriver can be used. However, the end where the blade of the screwdriver is recessed in a cavity is easier to use. The diagram below shows how to increase and decrease the energy.



The voltage measured by the meter is directly related to energy, so we will use it in the observations. As you vary the voltage record your observations about the change in the emitted light. When you have finished, you should be able to answer the following questions.

- ? What is the color of light emitted by the lamp?
 - ? How does the color of light change with voltage?
 - ? What is the voltage when the lamp barely emits light, called threshold voltage, and the voltage at maximum brightness?
 - ? How does the brightness of the lamp change with voltage?
- ? In the space provided below, record your measurements, observations and answers to the questions.

Remove the incandescent lamp from its socket and place an LED assigned by your instructor in the LED holder.

With the LED in the circuit adjust the potentiometer to vary the energy supplied to the LED. Measure the voltage for the LED. Again when you are finished you should answer the following questions:

- ? What is the color of light emitted by the LED?
- ? If the color of light changes with voltage, how does it change with voltage?

- ? What are the threshold voltage of the LED and the voltage at maximum brightness?
- ? How does the brightness of the LED change with voltage?

In the space provided below, record your measurements and observations. (If the LED does not come on for any voltage, record that information and continue to the next experiment.)

Color of Light Emitted by LED	Threshold Voltage (V)	Maximum Voltage (V)

Remove the LED from the circuit and reverse its connection to the socket. Repeat taking voltage measurements for the LED by focusing on the same four questions as before.

In the space provided record similarities to and differences from the previous investigation.

After everyone has completed the investigation, each group should share its results with the class. The resulting discussion should allow you to make a class table that illustrates the threshold voltage and voltage that results in maximum brightness for the incandescent lamps and LEDs in order of increasing voltage.

Light Source	Threshold Voltage (V)	Maximum Voltage (V)

Based on the results recorded by all groups, answer the following questions:

- ? What patterns do you see in the observations?

- ? How is the incandescent lamp similar to the LEDs?

- ? How is the incandescent lamp different from LEDs?

From our investigations, we found that the LEDs emit individual colors of light with different threshold voltages. Christmas lights are also examples of light sources that emit individual colors of light.

Examine one of the Christmas lights furnished by your instructor. Don't remove the lights from their sockets. The leads have a tendency to break off very easily.

- ? In the space provided below, describe the physical features of these Christmas lights by concentrating on what you can see inside the lamp.

Connect a Christmas light to the apparatus by using the terminals that are used for the voltmeter. Then, adjust the potentiometer to vary the voltage applied across the Christmas light. When finished answer the following questions:

- ? What is the color of light emitted by the Christmas light?
- ? If the color of light changes with voltage, how does it change?
- ? What are the threshold voltage of the Christmas light and the voltage at maximum brightness?
- ? How does the brightness of the Christmas light change with voltage?

? In the space provided below, record your measurements, observations and answers to these questions.

? Compare your results with others in the class by recording threshold voltage for each color of light.

? Based on your observations of the Christmas lights, make a prediction on whether the lights are incandescent lamps or LEDs. Explain your reasoning.

A final comparison between the LEDs and Christmas tree lights involve their colors. Summarize the similarities and differences in the color of light emitted by considering the following questions:

? Can you determine the color that will be emitted before you turn on a Christmas tree light and an LED? Why or why not?

? What property of the light source seems to determine the color?

Christmas lights, like LEDs, emit individual colors of light. However, all other physical properties of Christmas lights are similar to incandescent lamps. Incandescent lamps typically emit “white” light but can produce individual colors of light when a colored filter or coating is used. Christmas lights are examples of tiny, incandescent lamps that produce color due to colored coating found on the glass surrounding the tungsten filament. LEDs, unlike Christmas lights, emit various colors of light not as a result of the filament and a colored filter but as a result of a different process that we will learn more about in future activities. In the next activity, we will continue to investigate the physical properties of LEDs and compare these properties with an incandescent lamp and another light source – the gas lamp. This exploration may answer some of your questions and will certainly raise others.

Homework Question:

- Traffic lights emit their characteristic red (stop), yellow (caution), or green (go) light. Based on your observations and what you have learned, can you determine if traffic lights are incandescent lamps or LEDs? If yes, explain how. If not, describe an experiment that could make the determination (even if you cannot do the experiment).