

Name:

Class:

ACTIVITY 11

Can Ohm's Law Explain Your Observations?

Goal

In the first activity, we investigated the electrical and light emitting properties of LEDs and the incandescent lamp. In this activity, we will attempt to explain the electrical properties of the incandescent lamp and the LED.

Because the incandescent lamp and the LEDs are electrical devices, we might assume that these devices obey Ohm's law. For simple electrical components, such as resistors, Ohm's law states that the current flowing through a device is directly proportional to the voltage applied to it. This law is represented by the equation,

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

where for many devices the resistance (R) is a constant. We will determine whether Ohm's law with a constant resistance can explain the electrical properties exhibited by the incandescent lamp and the various LEDs investigated in the previous activity.

The best way to determine if an electrical device obeys Ohm's law with constant resistance is by graphing the variation of current (I) with the variation of voltage (V) across the device. A device that obeys Ohm's law exhibits a very characteristic I-V graph. For example, a graph of current (I) versus voltage (V) for a resistor with a given resistance exhibits typical Ohmic behavior as shown in Figure 11-1.

Note that the current-voltage graph is linear - that is, the slope (change in I divided by a change in V) of the graph is constant. A constant slope indicates that the electrical resistance is constant. Since the slope of the current-voltage graph is equal to $1/R$, the resistance can be determined by calculating the reciprocal of the slope.

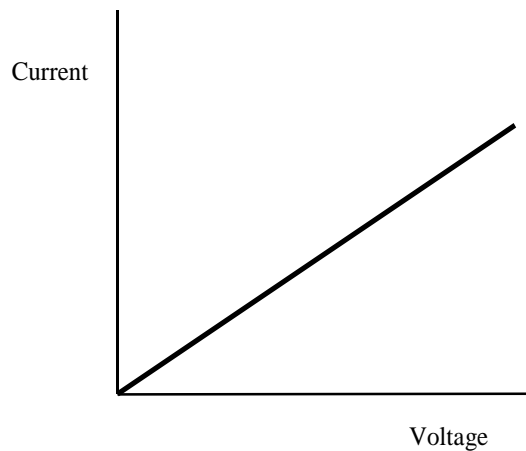


Figure 11-1: I-V Graph of a Resistor

- ? If you made measurements of current and voltage of a $33\ \Omega$ resistor and made a current-voltage graph, is the resulting graph consistent with the general shape of Figure 11-1?

Figure 11-1 can be explained in terms of the electrons in a material. When a voltage is applied to the devices, electrons are attracted to the positive and repelled by the negative side of the battery. They move through the material, and we measure that motion as current.

Because current is directly related to the number of electrons passing a certain location in the circuit in one second, it is related to both the number of electrons and their speeds. The resistance is a property of the material and is related to the availability of electrons and the ease with which they can move.

To determine if incandescent lamps and LEDs behave as simple resistors do, measure the current as a function of voltage of one LED and a Christmas tree light of the same color. Record and plot your data below.

Based on the current-voltage graph for the incandescent lamp, state whether this device appears to obey Ohm's law with constant resistance. Explain your answer.

? How about the LEDs? Do they appear to obey Ohm's law with constant resistance? Explain your answer.

As a starting point in understanding the current-voltage characteristics of the LED, we compare the relation between current and voltage with that of a device that obeys Ohm's law. We find that the LED's and incandescent lamp's variation in current with a change in voltage is quite different from the devices that obey Ohm's law with constant resistance. Our task for the remaining activities in the unit is to understand these differences.