**Simple Electrical Circuits**

In this activity we will explore simple circuits involving batteries, carbon resistors, light bulbs, and light emitting diodes (LEDs).

Light Bulb

Take a single battery, a light bulb, and one wire. Figure how to make the bulb light up.

Sketch your circuit below. Is there a continuous path for the current to flow from one side of the battery to the other side? If so, then trace the current path.

Bulb combinations

 V

A

B

C

Now consider the circuit to the right containing three light bulbs.

Before you wire the circuit, answer the following questions:

1. Which bulb will burn the brightest? (There may be more than one.)
2. Which bulb will burn the dimmest? (There may be more than one.)
3. What will happen to the brightness of the other two bulbs if you unscrew bulb

A? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(Note: Unscrewing a bulb does not mean reconnecting the wires.)

1. Now wire the circuit and check your predictions? (Note: Some bulbs may be so dim that there are hard to see if they are lit). Can you explain your results?

Resistance

You should have three or four resistors, each of which has color bands. Use the attached color chart to identify the resistance of each resistor.

Now use your multimeter to measure each resistance and compare with the values above.

You can also determine the resistance by connecting it to a battery and measuring the voltage and current. The diagram to shows how to insert the multimeter into the circuit to measure voltage and current. Calculate your resistance using *R = V/I* for a couple of the above resistors and compare with your values previously determined.

*Caution: Don’t place the multimeter in the ammeter setting directly across the battery and resistor. It will draw excessive current which may result in a blown fuse or damaged meter.*

Also, calculate the power dissipated in one of the resistors. Is this a safe value? It is probably rated at either ¼ W or ½ W.

Resistor Combinations

Two resistors can be connected either in series or in parallel, as shown below.

The addition rules for the equivalent resistance are

Series: 

Parallel: 

Calculate the series combination of two of your resistors. Place them in series and measure the resistance with the multimeter and compare with your calculation. *Note: Do NOT connect them to the battery when measuring the resistance.*

Repeat with the resistors in parallel.

Questions:

1. If your series resistors are connected to a battery, which resistor has the greatest voltage? Which has the greatest current? (Don’t actually make measurements. Just predict.)
2. If your parallel resistors are connected to a battery, which resistor has the greatest voltage? Which has the greatest current?

LEDs

(*Note: For this activity use the clear LEDs, not ones with colored lenses*.)

Power one of your LEDs using the circuit shown. Use two batteries in series so V ~ 3 volts and use R = 100 Ω. In powering a LED it is essential that you use an appropriate series resistor to limit the current. If the LED does not light up, then reverse the leads.

Measure the voltage drop across the LED and note the color of the emitted light. Repeat for your other LEDs.

What is the qualitative relationship between the wavelength of the light and the LED voltage?

Now, using one of the LEDS, replace the batteries with your hand-crank generator. What happens when you change the direction of the rotation of the crank?

Observe the effect of changing the crank speed on the following:

* Generator voltage
* LED voltage
* Light intensity
* Light color

Hopefully, you observed that the LED voltage and color changes very little as you increase the current (generator voltage), but the light intensity does increase as you increase the current.

Additional activity (if time allows or for further study)

(*Note: Use clear LEDs*.)

An LED can also work in reverse. That is, it can be used as a light sensor.

Measure the voltage across one of your LEDs. Bring a white light source near the LED and note the increase in voltage. This should work for all of the LEDs, but may work best for the red LED. (Why?)

You can use the LED to observe the dependence of light intensity on the distance (~ 1/r2). There is a maximum possible voltage output for the LED, so your measurements would have to be well below this value.

If you have a red laser pointer and a green laser pointer, you can note the effect of the laser light on the voltage output. A green laser will excite a red or yellow LED, but a red laser will not excite a yellow or green LED. Why is this so?

