Lab 14: Basic Circuits

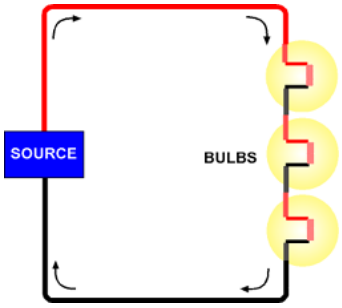
Purpose

To determine how batteries and light bulbs behave in different circuit arrangements and to find the resistance of a light bulb through Ohm's Law.

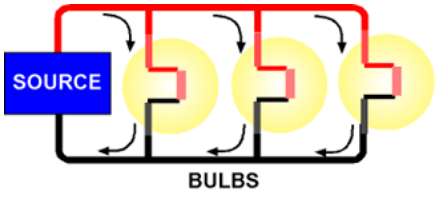
Introduction

Voltage is the ratio of electric potential energy to charge. One volt is one joule of energy per one coulomb of charge. Current is the volume of electric charge, or the number of charges per second moving past a point in an electric circuit. The unit for current is the ampere and one ampere is one coulomb of charge per second. In a simple circuit of a battery connected to a light bulb, the battery is a voltage source, and the light bulb is a resistance/load.

Light bulbs in a series circuit are connected end-to-end like links in a chain bracelet. Imagine a circuit with one light bulb in it. What would happen to the brightness of the light bulb if a second light bulb were added in series to the first light bulb? What would happen to the voltage across each individual bulb as more and more bulbs are added in series to the circuit? What would happen to the current through the circuit as more and more bulbs are added in series to the circuit?



Light bulbs in a parallel circuit are connected side-by-side like rung in a stepladder. Again imagine a circuit with one light in it. What would happen to the brightness of the light bulb if a second light bulb were added in parallel to the first light bulb? What would happen to the voltage across each individual bulb as more bulbs are added in parallel to the circuit? What would happen to the current through the circuit as more and more bulbs are added in parallel to the circuit?



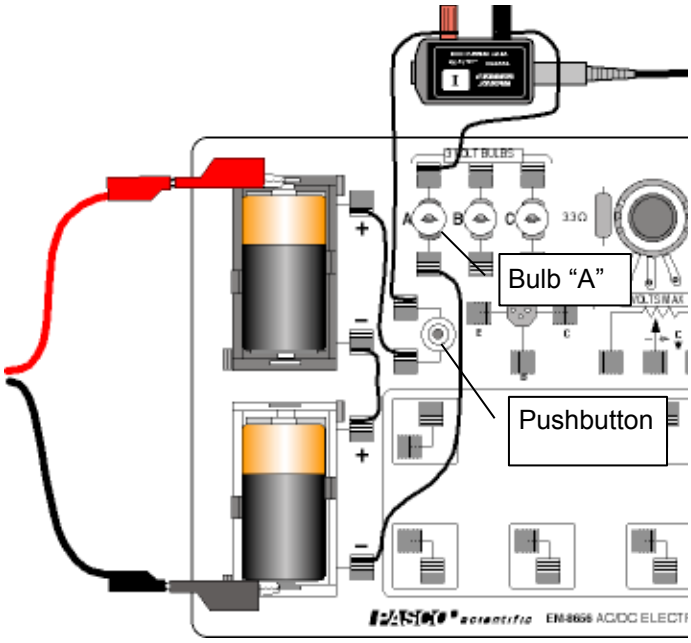
Light bulbs act as a resistance in a circuit. **Ohm's Law** tells you that when the voltage (potential difference) across a resistor changes, the current through the resistor changes. This is expressed as

$$I = \frac{V}{R} \qquad \textbf{Eq. 1 (Ohm's Law)}$$

where ***I*** is current, ***V*** is voltage (potential difference), and ***R*** is resistance. Current is directly proportional to voltage and inversely proportional to resistance. In other words, as the voltage increases, so does the current. The proportionality constant is the value of the resistance. Since the current is inversely proportional to the resistance, as the resistance increases, the current decreases.

Setup

1. Insert two ‘D’ cell batteries into the AC/ DC Electronics Laboratory board.
2. Use wire leads to build up a circuit with the two D cells, the pushbutton switch, the Current Sensor, and bulb “A” as shown.
3. Clip the leads of the Voltage Sensor to the positive and negative terminals of the battery holders as shown.

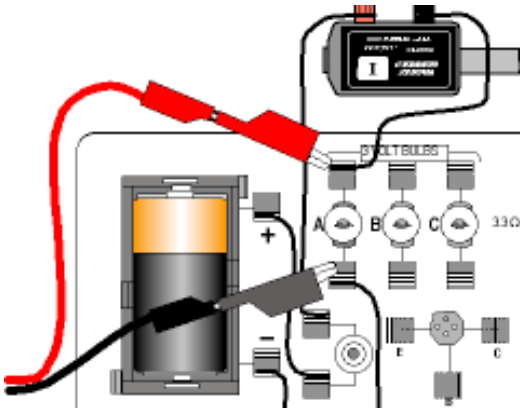


Procedure

Measure voltage and current for bulbs in series

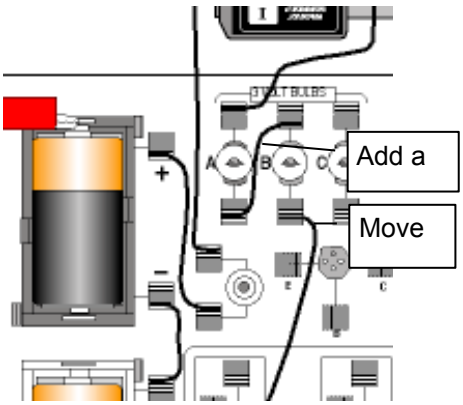
One Bulb

1. Press and hold the pushbutton switch. Observe bulb “A” and the Digits displays of Voltage and Current.
2. Record the values of voltage *across* the voltage source (D cells) and current *through* the circuit in the Lab Report section.
3. Move the Voltage Sensor leads to the spring clips on either side of bulb “A” and record the voltage *across* the light bulb.
4. Release the pushbutton switch.



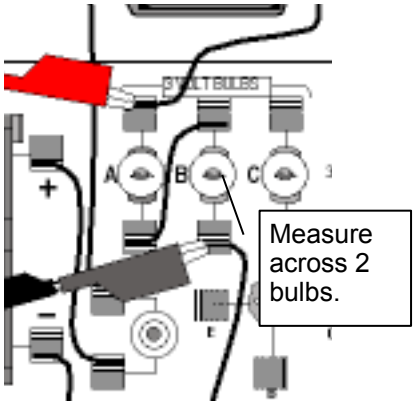
Two Bulbs in Series

5. Change the circuit to add bulb “B” in series. Move the wire lead from the negative terminal of the battery holder to the spring clip below bulb “B”. Add a wire lead from the spring clip below bulb “A” to the spring clip above bulb “B” as shown.
6. Press and hold the pushbutton switch.



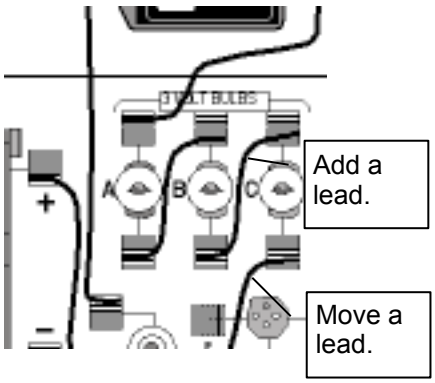
7. Record the values of voltage *across* the voltage source (D cells) and current *through* the circuit with two bulbs in series.

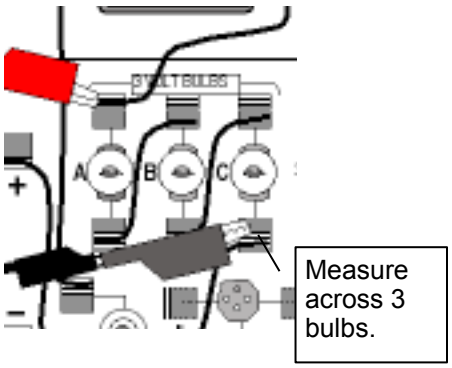
8. Move the Voltage Sensor leads to the spring clips on either side of bulb "A" and record the voltage *across* bulb "A" as before.
9. Move the Voltage Sensor leads to the spring clips on either side of bulb "B" and record the voltage *across* bulb "B".
10. Move the sensor leads so one is on the clip above bulb "A" and the other is on the clip below bulb "B" and record the voltage *across both bulbs*.
11. Release the pushbutton switch.



Three Bulbs in Series

12. Change the circuit to add bulb "C" in series. Move the wire lead from the negative terminal of the battery holder to the spring clip below bulb "C". Add a wire lead from the spring clip below bulb "B" to the spring clip above bulb "C" as shown.
13. Press and hold the pushbutton switch.
14. Record the values of voltage *across* the voltage source (D cells) and current *through* the circuit with three bulbs in series.
15. Move the Voltage Sensor leads to the spring clips on either side of bulb "A" and record the voltage *across* bulb "A" as before. Move the leads and measure the voltage across bulb "B". Move the leads and measure the voltage across bulb "C".
16. Next, move the sensor leads so one is on the spring clip above bulb "A" and the other is on the spring clip below bulb "C" and record the voltage *across three bulbs*.
17. Finally, unscrew any one of the three bulbs and record what happens to the other two bulbs. Screw the bulb back into its socket.
18. Release the pushbutton switch.

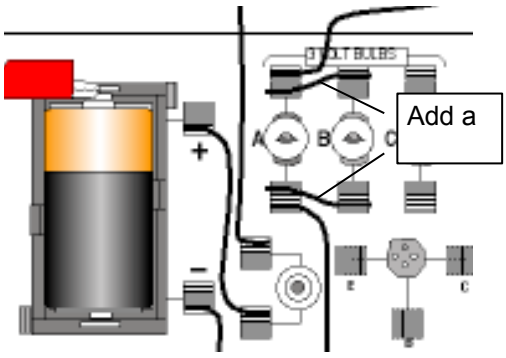




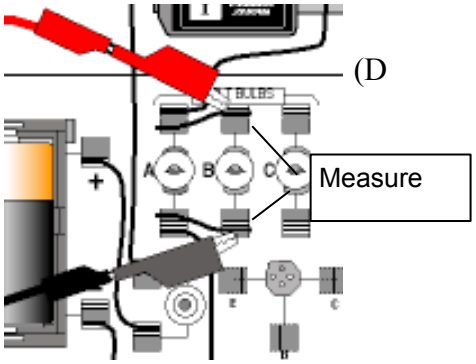
Measure voltage and current for bulbs in parallel

Two Bulbs in Parallel

1. Change the circuit to add bulb "B" in parallel to bulb "A". Add a wire lead from the spring clip above bulb "A" to the spring clip above bulb "B" as shown. Add a second wire lead from the spring clip below bulb "A" to the spring clip below bulb "B".

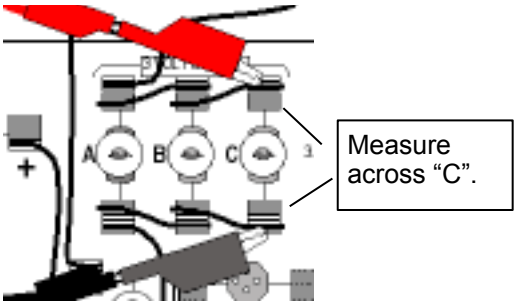


2. Press and hold the pushbutton switch.
3. Record the values of voltage *across* the voltage source cells) and current *through* the circuit with two bulbs in parallel.
4. Move the Voltage Sensor leads to the spring clips on either side of bulb "B" and record the voltage *across* bulb "B" as before.
5. Release the pushbutton switch.



Three Bulbs in Parallel

6. Change the circuit to add bulb "C" in parallel to the other bulbs. Add a wire lead from the spring clip above bulb "B" to the spring clip above bulb "C". Add a second wire lead from the spring clip below bulb "B" to the spring clip below bulb "C".
7. Press and hold the pushbutton switch.
8. Record the values of voltage *across* the voltage source (D cells) and current *through* the circuit with three bulbs in parallel.
9. Move the Voltage Sensor leads to the spring clips on either side of bulb "B" and record the voltage *across* bulb "B" as before. Move the leads to the spring clips on either side of bulb "C" and record the voltage *across* bulb "C".
10. Finally, unscrew any one of the three bulbs and record what happens to the other two bulbs. Screw the bulb back into its socket.
11. Release the pushbutton switch. Click 'Stop' in *DataStudio*.



Data

Procedure 1: Voltage and Current for Bulbs in Series	
One Bulb	
Item	**Value**
Voltage across voltage source	V
Current through circuit:	0.3 A
Voltage across bulb “A”	V

Procedure 2: Voltage and Current for Bulbs in Parallel	
Two Bulbs in Series	
Item	**Value**
Voltage across voltage source	V
Current through circuit:	0.21 A
Voltage across bulb “A”	V
Voltage across bulb “B”	V
Voltage across A and B	V

Two Bulbs in Parallel	
Item	**Value**
Voltage across voltage source	V
Current through circuit:	0.54 A
Voltage across bulb “A”	V
Voltage across bulb “B”	V
Voltage across A and B	V

Three Bulbs in Series	
Item	**Value**
Voltage across voltage source	V
Current through circuit:	0.17 A
Voltage across bulb “A”	V
Voltage across bulb “B”	V
Voltage across bulb “C”	V
Voltage across A to C	V

Three Bulbs in Parallel	
Item	**Value**
Voltage across voltage source	V
Current through circuit:	0.70 A
Voltage across bulb “A”	V
Voltage across bulb “B”	V
Voltage across bulb “C”	V
Voltage across A to C	V

Analysis

Complete the Lab 14 quiz on Canvas/iLearn.