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Lamp Board with Buss Bars
#1200-14

Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **California Proposition 65 Warning: This product can expose you to chemicals including lead and ethyl acrylate, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.**

$$I = \frac{V}{R}$$

Introduction

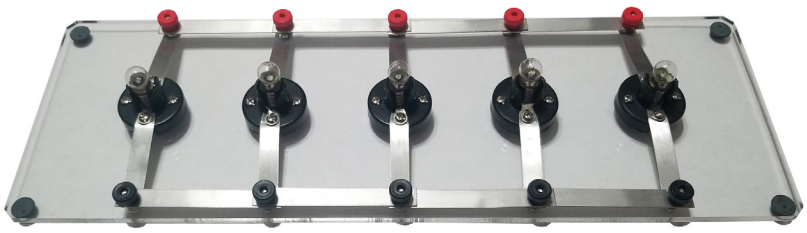
The ability to manipulate electrical currents has been one of the most consequential scientific discoveries of the last two centuries. With electrical circuits, we are able to create powerful computers and supply electrical power with precision. Your lamp board will help you to gain a basic understanding of electrical circuit lay outs and Ohm's Law.

Ohm's Law explains the simple mathematical relationship between the electrical properties of **voltage (V), current (I),** and **resistance (R).** It is shown to the left. **Voltage** can be thought of as the amount of electrical potential energy in a circuit. **Current** can be thought of as the amount of electrical charge flowing past any given point in a circuit at any given second. **Resistance** can be thought of as a measurement of how much current is slowed by a resistance point, referred to as a **resistor,** in a circuit.

Understanding Ohm's Law will allow you to better realize how electricity gets distributed throughout a given circuit. Circuits can be characterized by the arrangement of resistors within it. **Series circuits** contain resistors that are linked one after the other so that only one path is available through the circuit for electricity to flow. **Parallel circuits** are arranged so that the resistors in the circuit each lie on a unique possible path for the electricity to flow. Series and parallel resistors can be combined within a single circuit to create many unique circuits. You can see examples of each on the next page.

In this experiment, your lamps will represent the resistors in your circuit. The brightness of each lamp along the circuits you build will show you how electrical energy is distributed in your circuits and help you to visualize Ohm's Law. You will need the following **additional supplies:**

- 1 Power source (6V is the recommended limit. Higher voltages will burn out your lamp bulbs.)
- Lead wires (These will complete your circuits, but a knife switch may also be helpful for operating each circuit.)
- 1 Multimeter **(Optional:** This tool is only necessary to take actual measurements of electrical properties in your circuit. You will be able to visualize this experiment without hard data, however.**)**

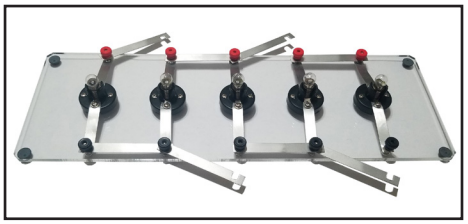


How to Use

Resistance, one of the variables in Ohm's Law described previously, is tallied up differently depending on what type of circuit you are working with. In a series circuit, voltage is divided across the resistors and each additional resistor increases the resistance in the system. In a parallel circuit, on the other hand, voltage is the same across all the resistors and each additional resistor decreases the resistance.

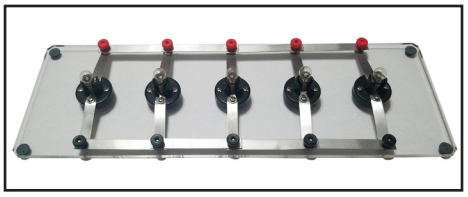
Series Circuits	Parallel Circuits
$V_{Battery} = V_1 + V_2 + V_3 + V_4 + V_5 + \ldots$	$V_{Battery} = V_1 = V_2 = V_3 = V_4 = V_5 = \ldots$
$R_{Total} = R_1 + R_2 + R_3 + R_4 + \ldots$	$\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \ldots$

Series and Parallel Circuits



Board with Series Circuits

1. Set up your board as shown in the series circuit example to the right. This represents the largest series circuit possible with your board.
2. Attach your power source to the lamp board by loosening the necessary screw knobs enough to slip your lead wires in next to the metal bar before tightening down the screws again. For this configuration, using the picture as reference, attach one of your wires to the red screw in the top left corner and the other to the black screw in the bottom right corner. (For smaller series circuits, just simply connect to the endpoints of the series of resistors.)
3. Power on you lamp board.
4. Observe that each bulb is less bright than the one before it in the series.
5. Detach your power source for safety before setting up your next circuit.
6. Set up your board as shown in the parallel circuit example to the right. This set up represents the largest parallel circuit you can make with your board.
7. Attach your power source to the lamp board as described above. For this configuration, attach one of your wires to the red screw in the top left corner and the other to the black screw in the bottom left corner. (For smaller parallel circuits, these connection points remain the same.)

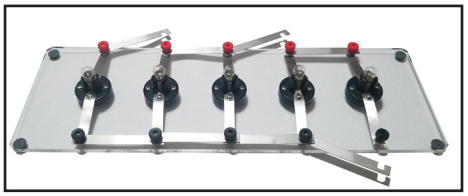


Board with Parallel Circuits

8. Power on you lamp board.
9. Observe that each bulb is just as bright as every other bulb in the parallel circuit.
10. Detach your power source for safety before setting up your next circuit.
11. Repeat the steps above to experiment with smaller parallel and series circuits. Are your observations the same?

Combination Circuits

1. Set up your lamp board as shown in the combination circuit example to the right. This set up contains one parallel connection amid the other series connections.
2. Repeat the steps in the first experiment to turn on your lamp board as it is set up. Connect your wires to the endpoints of the series resistors.
3. How does this combination affect each bulbs brightness? Experiment further with even more combinations.



Board with Combination of Circuits