Ohm's Law

Objective: To demonstrate Ohm's law and to determine the resistance of a given resistor.

Theory: Electric current is the moving of charges from a higher potential to a lower potential. If an amount of charges, Δq pass through a cross sectional area in a given time, Δt then current, I is defined as:

$$I = \frac{\Delta q}{\Delta t}$$

If a small potential difference e is applied to a copper wire, and the same potential difference is applied to a silver wire of same cross sectional area, there will be a difference in the current within the wire. This characteristic of the wire is known as the resistance. Ohm's law is the assertion that the current through a device is always directly proportional to the potential difference applied to the device.
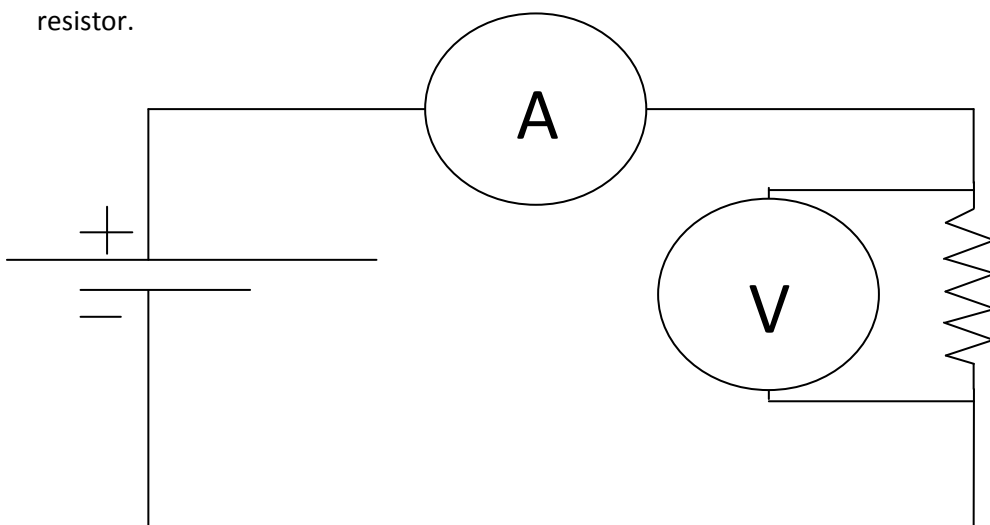
$$V \propto I$$

$$V = RI$$

Here R is the proportionality constant which is the resistance of the object. The units are shown thusly:

$$1\,V = 1\,\Omega * 1\,A$$

$$1\,\Omega = \frac{1\,V}{1\,A}$$

Below is a diagram of the circuit incorporating the power supply, ammeter, voltmeter, and the resistor.

In the above diagram, R is the resistor, V is the voltmeter which measures the voltage across the resistor and A is the milli-ammeter which measures the current through the resistor.

Apparatus: 2 multi-meters (set on the 20 mA and 20 V scale), unknown resistor board, and the Extech Instruments (0 - 18 Volts) Power Supply.

Procedure:

1. Construct the above circuit.
2.   Choose the 20 milli-ampere range on the ammeter and 20 V on the voltmeter.
3. Get the connections checked by the instructor.
4. Plug the power cord into an electrical outlet and turn on the unit.
5. Start with 15 volts.
6. Record both the voltage (V) and the current (*I*) values in the table below
7. Repeat this procedure to obtain records of V and I for successive voltages in 1 volt increments down to 5 volts.
8. Plot a graph of I as a function of V using computer. Fit the straight line that best fits the data. Determine the slope of this line, which equals the resistance of the resistor. (On the computer, open DataStudio and choose cancel on the "OPEN" window. Choose the "experiment" tab-scroll down and click on "New empty data table". Enter data, and then drag data icon to the graph icon on left of screen to plot. Then fit your data to the best straight line and print.
9. Repeat for resistors #7 and #9.

Resistor #2

Reading	Current (I)	Voltage (V)
1		
2		
3		
4		
5		
6		

Resistor #7

Reading	Current (I)	Voltage (V)
1		
2		
3		
4		
5		
6		

Resistor #9

Reading	Current (I)	Voltage (V)
1		
2		
3		
4		
5		
6		

Resistors in Series: If a potential difference is applied across resistances connected in series, the current through the resistors is constant. An equivalent resistor may replace the resistors in series.

$$V = R_1 I + R_2 I$$

$$V = I(R_1 + R_2)$$

$$R_{equ} I = I(R_1 + R_2)$$

$$R_{equ} = R_1 + R_2$$

Resistors in Parallel: If a potential difference is applied across resistances connected in parallel, the potential difference across the resistors is constant. An equivalent resistor may replace the resistors in parallel.
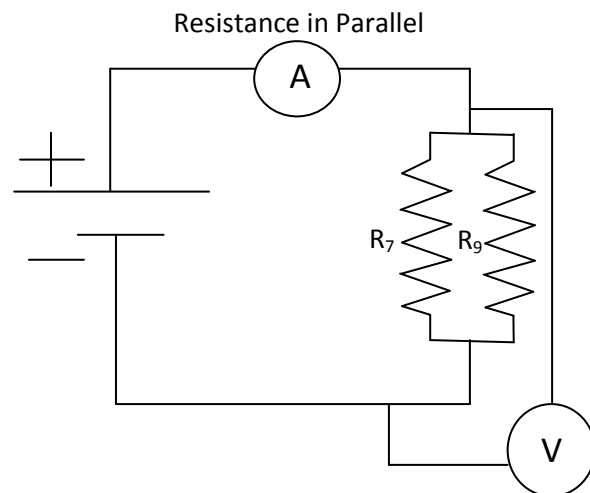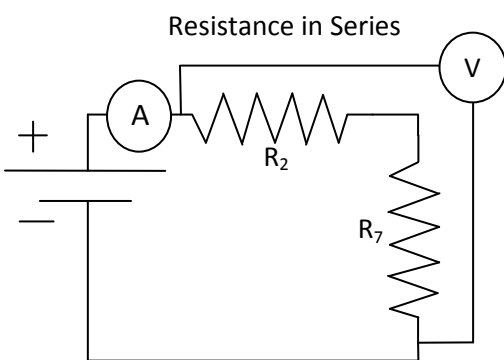
$$I = \frac{V}{R_1} + \frac{V}{R_2}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{V}{R_{equ}} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{R_{equ}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{equ} = \frac{R_1 * R_2}{R_1 + R_2}$$

Resistance in Series

Resistance in Parallel

Procedure:

1. Construct the above circuit with resistance in series.
2. Choose the 20 milliampere range on the ammeter and 20 V on the voltmeter.
3. Get the connections checked by the instructor.
4. Plug the power cord into an electrical outlet and turn on the unit.
5. Start with 15 volts.
6. Record both the voltage (V) and the current (I) values in the table below
7. Repeat this procedure to obtain records of V and I for successive voltages in 1 volt increments down to 5 volts.
8. Plot a graph of I as a function of V using computer. Fit the straight line that best fits the data. Determine the slope of this line, which equals the equivalence resistance of the resistor.
9. Repeat for parallel resistance.
10. Use previous data to measure percent error of the series and parallel circuit.

#2 and #7 in Series

Reading	Current (I)	Voltage (V)
1		
2		
3		
4		
5		
6		

#7 and #9 in Parallel

Reading	Current (I)	Voltage (V)
1		
2		
3		
4		
5		
6		