Conceptually Understanding Linear Functions

Overview:

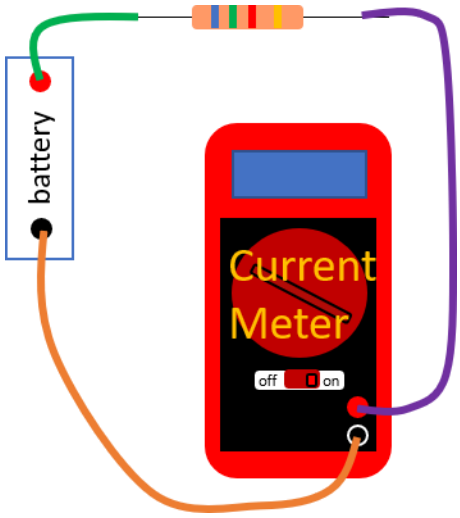
Electrical devices work through the flow of electrons, which are charged particles. For an electrical circuit to work, it must have something that provides power (like a battery), something that consumes power (like a resistor), and wires must connect everything in a circle, so the electrons can flow. The battery has a given *voltage*, which provides the "umph" needed to get the electrons flowing. We call the flow of electrons *current*.

How much current flows depends on the voltage of the battery and the resistance of the resistor. According to the famous electrical engineering equation Ohm's Law,

$$\textbf{Voltage} = \textbf{Current} \cdot \textbf{Resistance}$$
$$V = I \cdot R$$

This is a linear equation. That means that for a given resistor, the ratio of the voltage and current will remain constant. More generally, if any one of the variables in the equation is held constant, the other two will be in a fixed proportion or ratio.

1. Build the following circuit by connecting a AA battery, the 1 resistor, and the current meter in a loop. Record the current. A single battery has a voltage of approximately 1.5 volts. Use this information and Ohm's Law to figure out what the resistance of the resistor is.



(given) **Voltage = 1.5**

(measure) **Current =**

(calculate) **Resistance =**

2. How close is this to the labeled resistance? Why is it not exact?

Now we will make changes to the original circuit. Use the equation Ohm's Law to *predict* what will happen in the following situations.

3. By putting two batteries in a row, we can double the voltage. If we use the same resistor, how will the current change?
   a. First determine which variable is fixed (constant), which variable is the independent variable, and which variable is the dependent variable. *Hint: Remember that the independent variable is the one we are controlling.*

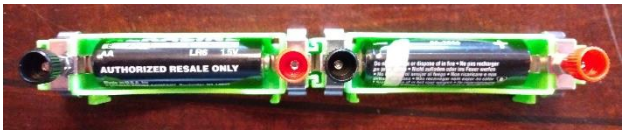
(circle one for each)

Constant	Voltage	or	Current	or	Resistance
Independent Variable	Voltage	or	Current	or	Resistance
Dependent Variable	Voltage	or	Current	or	Resistance

   b. Now predict how the current will change if the voltage is doubled using Ohm's Law: Voltage = Current · Resistance. *Hint: It may be helpful to rearrange the equation so the dependent variable is by itself.*

If the voltage is doubled, then the current will STAY THE SAME / DOUBLE / HALF (circle one).

   c. Build the circuit and confirm your prediction. Make sure you put your batteries with the red sides facing in the same direction.



Current =

The current DOUBLED / HALVED / STAYED THE SAME (circle one)

compared to the current measured in 1.

4. By putting two resistors in a row, we can double the resistance. If we use the same single battery as the original situation, then how will current change?
   a. What are the constant, independent variable and dependent variable this time?

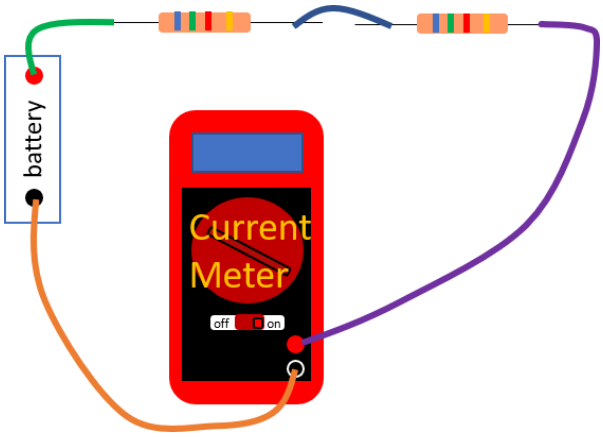
(circle one for each)

Constant	Voltage	or	Current	or	Resistance
Independent Variable	Voltage	or	Current	or	Resistance
Dependent Variable	Voltage	or	Current	or	Resistance

   b. Predict how the current will change if the resistance is doubled using Ohm's Law: Voltage = Current · Resistance
   Hint: It may be helpful to figure out if the dependent and independent variable are proportional or inversely proportional.

If the resistance is doubled, then the current will STAY THE SAME / DOUBLE / HALF (circle one)

   c. Build the circuit and confirm your prediction. There is a second resistor of resistance 1 in the plastic baggie.



Current =

The current DOUBLED / HALVED / STAYED THE SAME (circle one)

compared to the current measured in 1.

5. *(Bonus)* What happens if you make both changes at once? (Add two batteries in a row and two resistors in a row)
   a. Predict how the current will change.

If both the voltage and resistance are doubled, then the current will

STAY THE SAME / DOUBLE / HALF (circle one)

compared to the current measured in 1.

   b. Confirm your prediction by building the circuit.

Current =

The current DOUBLED / HALVED / STAYED THE SAME (circle one)

compared to the current measured in 1.