Name: _____

Ohm's Law Worksheet

Discussion Overview

Ohm's Law

Ohm's law is the most basic law of electricity. It was formulated in 1827 by the German physicist and mathematician Georg Simon Ohm. Through his experiments, Ohm discovered the relationship between voltage difference, current and resistance. He noticed that he increased the voltage difference across a fixed resistance, the current increased proportionally. In language of math, we should this direct proportionality as follows.

$I \propto V$

On the other hand, he noticed that if he kept the voltage difference the same but increased the resistance, the current decreased. Therefore,

$I \propto \frac{1}{R}$

No other parameter in the circuit affected the amount of current. Therefore, voltage difference and resistance were the only factors affecting the current flowing in the circuit. Based on these observations, he derived the following equation known as Ohm's law.

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

The unit of potential (voltage) difference is Volts; that of resistance is Ohms (Ω); and the unit of current is Amperes. If V is given in mV and R in Ohms, current will be in mA.

Other useful forms of Ohm's law are

$V = IR$

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

Name: _____

Power Supplies

Power supplies are electronic adjustable voltage sources. The power supply we use in our projects is the Tekpower TP3005T shown below.

Figure 1 - Tekpower TP3005T Variable Linear DC Power Supply

As seen in Figure 1, this power supply has voltage and current knobs to set the output voltage and the current limit. To set the output voltage,

1. Push the “Voltage knob” in momentarily.
    - This will activate the output voltage setting.
    - The voltage reading digits on the digital display will also start blinking to indicate that the power supply is in output voltage setting mode.
    - By repeatedly pressing the “Voltage” knob, one can cycle through the decimal position of the voltage setting. For example, when the “Voltage” knob is first pressed, the digit in the tens place might be blinking. Turning the knob at this point will change the output voltage by multiples of ten. In order to set the output voltage by steps of one, press the knob in. This will change the blinking digit to the one for the ones position.
2. By repeatedly pressing the “Voltage” knob and turning it, one can set the voltage to any value from 00.00V to 30.00V.

Similarly, one can set the maximum current the power supply is to provide. By setting this “current limit”, one can prevent a circuit from getting damaged inadvertently. To set the current limit, use the “Current” knob and follow the same instructions as the ones given for setting the

output voltage. The output current of the TEKPOWER TP3005T can be set from 0.000A to 5.000A.

During normal operation, the digital display on the power supply displays the actual output voltage and the current provided by the power supply to the circuit.

The TEKPOWER TP3005T comes with a pair black and red alligator test clips. The straight leads of the test clips are plugged into the power supply. The black lead is plugged into the negative (black) output of the supply, and the red lead is plugged into the positive (red) output of the supply.

The green output is the neutral port. This port is connected to the third (ground) prong of power supply's power cord. The green port is usually not used. Its main use is to be connected to the metal body of the equipment that is powered by the power supply. This will allow a path for the current to the "ground" if there is an accidental short of power to the body of the equipment.

Voltmeters

Voltmeters (usually part of a multi-meter) are used for measuring the voltage difference between two points in a circuit. Since voltmeters measure voltage differences, the probes are placed across the circuit of interest (for example, a resistor).

The positive or red lead of the voltmeter is connected to the point where the current enters the circuit, and the negative or black lead is connected to the point where the current leaves the circuit. If you do not know the direction of the current, connect the probes in a configuration of your choosing. If the measured voltage is positive, it means that the current is entering the circuit where the positive or red lead is connected, and it's exiting the circuit where the negative or black lead is connected. If the measured voltage is negative, then the current is flowing in the opposite direction of what you thought.

To use a voltmeter, follow the steps below:

1. Set the multi-meter for measuring voltage. Make sure the setting reflects the range of voltages you are trying to measure.
2. Connect the positive and negative lead across the circuit or component that you are trying to measure the voltage difference for.
3. Read out the measured value on the multi-meters display. Pay close attention to the units displayed on top of the display.

Ammeters

Ammeters (usually part of a multi-meter) are used for measuring the current in a circuit.

Since ammeters measure the flow of electricity, they need to be inserted in line with the circuit. (This is unlike voltmeters where the probes are applied across the circuit.) Therefore, to measure the current in a part of a circuit, either the wire coming into the circuit or the wire leaving the circuit is broken, and the ammeter is inserted in the circuit in place of the wire.

Name: _____

The positive or red lead of the ammeter needs to be connected to the point where the current enters the ammeter, and the negative or black lead needs to be connected to the point where the current leaves the ammeter. If you do not know the direction of the current, connect the ammeter in a configuration of your choosing. If the measured current is positive, it means the current is entering the positive lead and leaving the negative lead. If the measured current is negative, it means that the current is entering the negative lead and leaving the positive lead.

Ammeters usually have two possible red lead inputs; one is for measuring currents in mA range while the other one is used for measuring currents in multiples of Amperes. The mA input is usually fused, and if the amount of the current going through the ammeter is larger than the range specified on the ammeter, the fuse burns out leaving the ammeter inoperable.

The input for measuring multiples of Amperes is usually not fused; however, the measurements do not carry as much precision as the input for mA range.

Never insert an ammeter into a live circuit! Follow the steps below for using an ammeter:

1. Disconnect the power source from the circuit.
2. Identify the point at which you would like to measure the current.
3. Break the circuit at the point of measurement by removing the wire at that point.
4. Insert the ammeter in the circuit in place of the wire you just removed.
5. Set the multi-meter to the measure current (ammeter mode)
6. Make sure the positive or red lead is connected to the input with the correct current rating.
7. Now, you can reconnect the power source to measure the current.

Name: _____

Schematics

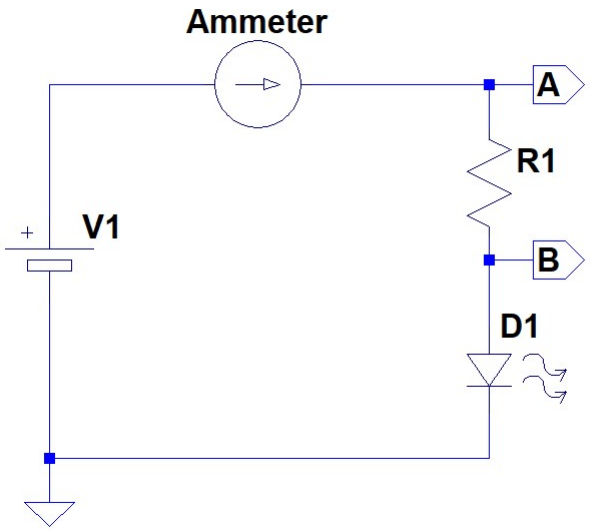

Figure 2 – Resistor and LED Circuit

Procedure

A. Build the circuit shown in Figure 2.
   a. Use the TEKPOWER TP3005T power supply in place of V1.
   b. Use an LED color of your choosing for D1.
   c. Insert the ammeter where shown when you are instructed to measure the current.
   d. For this lab, you will be asked to measure the voltage across R1 (points A & B) and the current flowing through R1 for different values R1 and V1.

B. **Before** connecting the power supply to your circuit,
   a. Set its output voltage to 5V, and
   b. Set its output current limit to 15mA.

C. For the values of resistors shown in the table below,
   a. Measure the actual value of your resistor, and record the value in the table below.
   b. Measure the voltage across the LED D1 (points B and ground), and record it in the table below.
   c. Calculate the voltage across R1 and record it in the table below. *(Hint: $V_{R1} = V1 - V_{LED}$)*
   d. Measure the voltage across R1 (points A and B), and record it in the table below.
   e. Calculate the current flowing through R1 and D1, and record it in the table below. *(Hint: Use Ohm's Law!)*
   f. Measure the current flowing through R1 and D1, and record it in the table below.

Name: _____

g. Observe the “relative” brightness of the LED, and record it in the table below.

Table 1 - Voltage & Current for R1

R1 (Ω)	Measured R1 (Ω)	Voltage Across D1	Calculated V Across R1	Measured V Across R1	Calculate I thru R1 & D1	Measured I thru R1 & D1	Relative Brightness of D1
200							
390							
1K							

D. Based on your measurements in Table 1, answer the following questions:
   a. Did your calculated current through R1 and D1 match your measured results?

   b. If no, why not?

   c. How did the current through R1 and D1 change with respect to the value of R1?

   d. How did the brightness of the LED change with respect to the current through R1 & D1?

E. For this part of the lab, you will work with a single resistor but will adjust the power supply’s output voltage to achieve a certain current (given in the table below) through the resistor and LED,
   a. Use a 620Ω resistor for R1.
   b. Measure the actual value of your resistor, and record the value in the table below.
   c. Use the average of the voltages measured across the LED D1 from Table 1, and record it in the table below.
   d. Calculate the voltage across R1 for the given current. *(Hint: Use Ohm’s Law!)*

Name: _____

e. Determine the voltage setting for the power supply based on the voltage calculated in part d above, and record it in the table below. *(Hint: $V1 = V_{LED} + V_{R1}$)*
f. Set the power supply's output voltage to the one calculated in part e.
g. Measure the current flowing through R1 and D1, and record it in the table below.
h. Observe the "relative" brightness of the LED, and record it in the table below.

Table 2 – Setting Output Voltage

Target Current (mA)	Measured R1 (Ω)	Voltage Across D1	Calculated V Across R1	Calculated Power Supply Voltage	Measured I thru R1 & D1	Relative Brightness of D1
15						
11						
7.9						

F. Based on your measurements in Table 2, answer the following questions:
   a. Did the measured current through R1 and D1 match the targeted value?

   b. If no, why not?

   c. How did the current through R1 and D1 change with respect to the voltage setting?