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Physics 4B

Ohm's Law

Introduction: Ohm's Law defines the relationship between voltage (V), current (I) and resistance (R). R depends upon the material from which the device is constructed and the geometry of the material. Ohm's law is defined by I=V/R, where one ohm is the resistance value through which one volt will maintain a current of one ampere. Resistance determines how much current flow through a component. High resistance will allow very little charge to flow, while a small resistance will allow a larger current to flow through.

A conductor that treats R as a constant is said to be ohmic because the current is proportional to its voltage. A non-ohmic element does not follow ohm's law. Telling apart an ohmic and non-ohmic resistor can be done by graphing current vs. voltage, a linear graph will result and in ohmic resistor while a non-ohmic will not follow a linear path. The purpose of this lab is to investigate the behavior of a resistor, light bulb and led light by graphing the current vs. voltage.

Procedure:

Equipment needed:

- Power Supply
- Breadboard
- 1k Ω resistor
- 22 Ω resistor
- 6.3 V light bulb
- Green LED
- 2 Digital multi-meters with cables

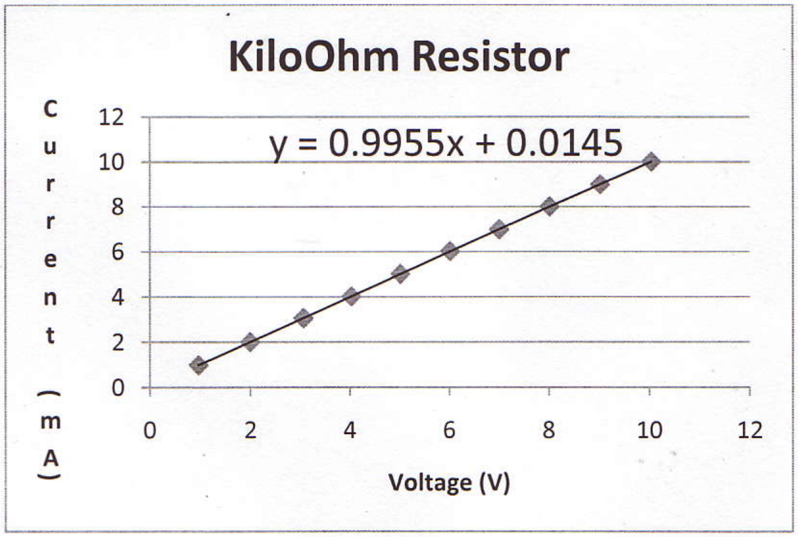
Part 1A: Build a simple circuit with a 1k Ω, adjust the power supply until the voltage across is 1.0V. Increase the voltage by increments of 1.0V until reaching 10.0V, record current and voltage. Part1B: Build a simple circuit with a 22 Ω resistor, adjust the power supply until the voltage across is 0.5V. Increase the voltage by increments of 0.5V until reaching 5.0V, record current and voltage.

Part 2A: Build a simple circuit consisting of a 6.3V light bulb. Adjust the voltage across the bulb to 1.0V and record current and voltage. Increase voltage in 0.5V increments until reaching 5.0V, record data. Part 2B: Build a simple circuit consisting of a green LED. Adjust the voltage across the LED to 0.5V and record current. Increase the voltage to 1.0V then 1.5V and record the current though the LED. Take 10-20 values between 1.5-2.0V and record the current across the LED.

Data Analysis:

After observing the current for 30 seconds on the 1k Ω after reaching 10V across and observed no change. As the current flows through the conductor the temperature is probable to change and when it does, it will affect its current flow.

1k Ω			
Voltage (V)	Current (mA)	Expected Current (mA)	Percent Difference
0.968	0.98	0.968	1.24%
1.996	2	1.996	0.20%
3.064	3.06	3.064	0.13%
4.025	4.02	4.025	0.12%
5.014	5.01	5.014	0.08%
6.015	6.01	6.015	0.08%
7	6.98	7	0.29%
8.01	7.99	8.01	0.25%
9.02	8.99	9.02	0.33%
10.04	10.01	10.04	0.30%



Reversing the polarity of the voltage across the resistor did not make a difference in the current. Graphing the current vs. voltage proved that the 1k Ω resistor is ohmic. Having the graph linear proofs the resistance is constant and therefore, current is proportional to its voltage.

too strong

$R=\frac{1}{m}=\frac{1}{0.995}=1.00$

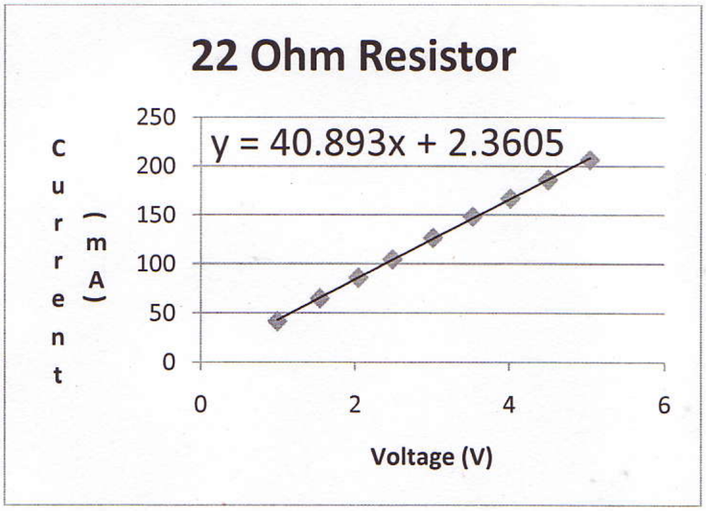
Percent Difference $= (\frac{Mea}{Exp} - 1) = (\frac{0.98}{0.968} - 1)*100 = 1.24\%$

The percent difference was 1.24% and faulty connections could have been contributed to the error.

After the voltage reached 10.0V across the 22 Ω , we observed a change in current after 30 seconds. The reason the current was decreasing was because the temperature of the conductor was increasing causing the atoms and molecules to get excited. The excitement of the molecules impeded charge to flow through. When the voltage was lowered to 1.0V the current was different than the previous reading. This has to do with the temperature difference between the first data recording and the final.

22 Ω Resistor

Voltage (V)	Current (mA)	Expected Current (mA)	Percent Difference
0.991	41.7	45.05	7.43%
1.542	64.92	70.09	7.38%
2.044	85.9	92.91	7.54%
2.485	104.6	112.95	7.40%
3.012	126.5	136.91	7.60%
3.527	148.4	160.32	7.43%
4.013	167	182.41	8.45%
4.497	186	204.41	9.01%
5.037	206.4	228.95	9.85%

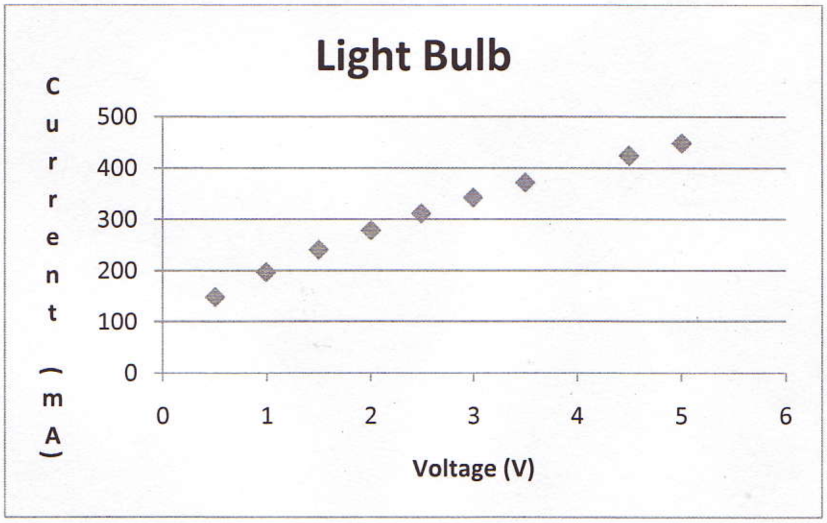


$R = \frac{1}{m} = \frac{1}{40.89} = 0.02$ Percent Difference = $(\frac{Mea}{Exp} - 1) = (\frac{41.7}{45.05} - 1) * 100 = 7.4\%$.

The resistance is approximately constant and the percent difference for the 22Ω resistor is 7.4%. Results could have been affected because of faulty connection and misreading current values. The experiment showed both 1kΩ and 22Ω resistors obeying ohm's law and are both ohmic.

Light Bulb

Voltage (V)	Current (mA)
0.504	148.1
0.992	196.6
1.499	240.4
2.004	278.4
2.492	311.5
2.994	342.7
3.498	371.8
4.497	424.5
5.002	448.5

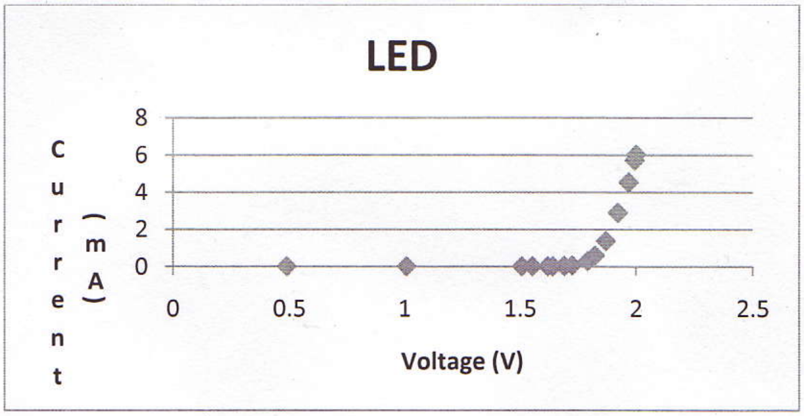


The light bulb did not obey ohm's law and is non-ohmic. The graph of current vs. voltage proofs that the light bulb is non-ohmic because it does not follow a linear path. The light bulbs filament is not constant because of the heat created by the light.

The green LED has a turn on voltage of 1.791V, with a current of 0.29mA. The LED is a non-ohmic because the graph does not show a linear path.

Green LED

Voltage (V)	Current (mA)
0.488	0.02
1.008	0.02
1.508	0.02
1.553	0.02
1.641	0.02
1.62	0.02
1.691	0.04
1.725	0.07
1.791	0.29
1.823	0.6
1.87	1.38
1.922	2.9
1.968	4.54
1.994	5.73
2	6.03



Conclusion:

This lab had us creating four different circuits with different resistors and lights. The purpose was to determine whether they follow ohm's law and to determine if they are ohmic or non-ohmic.

The experiment concluded that the 1k Ω obeyed ohm's law and is ohmic. By observing the linear graph of current vs. voltage, confirm my prediction. The percent difference was 1.24% and faulty connections could have caused an error. The 22 Ω resistor obeyed ohm's law and was ohmic as well. The percent difference was 7.4% and a human error could have been part of the large error. Recording wrong values could have affected our results. The two resistors have differences between them as proven in part 1b. The current across a 10.0V circuit differ from the previous recording just minutes earlier. This had to do with the increase in temperature change inside the conductor exciting all atoms and molecules. The 1k Ω resistor did not act the same.

The light bulb did not follow ohm's law, and is non-ohmic. The non-linear graph of current vs. voltage agrees with the light bulb being non-ohmic. The light bulbs filament does not have a constant resistance because as the light bulb heats up it causes the temperature of the conductor to increase. This causes charge to decrease as temperature increases. The LED had a turn on voltage of 1.691V with a current of 0.29mA and is non-ohmic. Our experiment proves that only resistors with a constant resistance are ohmic and not all resistors are exactly the same