Ohm's Law

49/50

March 17, 2005

Instructor: Dr. Orville Bignall
Physics 2021

5/5

Abstract

In this experiment we utilized Ohm's law by applying his concepts to five trials of measuring voltage and current flowing through a closed system. From these trials we constructed a graph that we use to determine potential difference, the amount of current flowing through the system, and the resistance of the wire used in this experiment. Upon completing this experiment, we were able to determine the experimental resistivity for 10 meters of #22 B&S Nickel Silver wire to be 3 x 10^-7 Ω*m. Compared to the known value of resistivity for this particular wire, which is 2.9 x 10^-7 Ω*m, we obtained a percent difference value of 3.3%.

5/5

Introduction

Ohm's law deals with the relationship between voltage and current in an ideal conductor. Ohm's law states that the potential difference across an ideal conductor is proportional to the amount of current flowing through the system and the resistance is known as the constant of proportionality. The current involved in defining Ohm's law is what flows through a wire or conductor from points of high voltage to points of low voltage on the surface of a conductor and is measured in Amperes. Voltage is the difference in electrical potential between two points in a circuit and is measured in volts. The resistance defines how much current will flow through a component. Ohm's law is further stated by the ideal that the potential difference between two points of a system is equal to the amount of current flowing through the system times the resistance of the material used in the system. Plotting the measurement of current versus the voltage, for a material that follows Ohm's law, results in a straight line, with a constant slope equal to 1/R.

5/5

The resistance involved in Ohm's law can be broken down to state that it is proportional to the length of a given material and is inversely proportional to the area of the material. Resistance is defined by the resistivity of a material times the length over the area of that material.

In theory, by applying Ohm's law to the values given by five trials of measuring voltage and current in a system, we will be able to construct a graph, which will in turn give us an equation to use to determine the resistivity for 10 meters of #22 B&S Nickel Silver wire.

Experimental Techniques

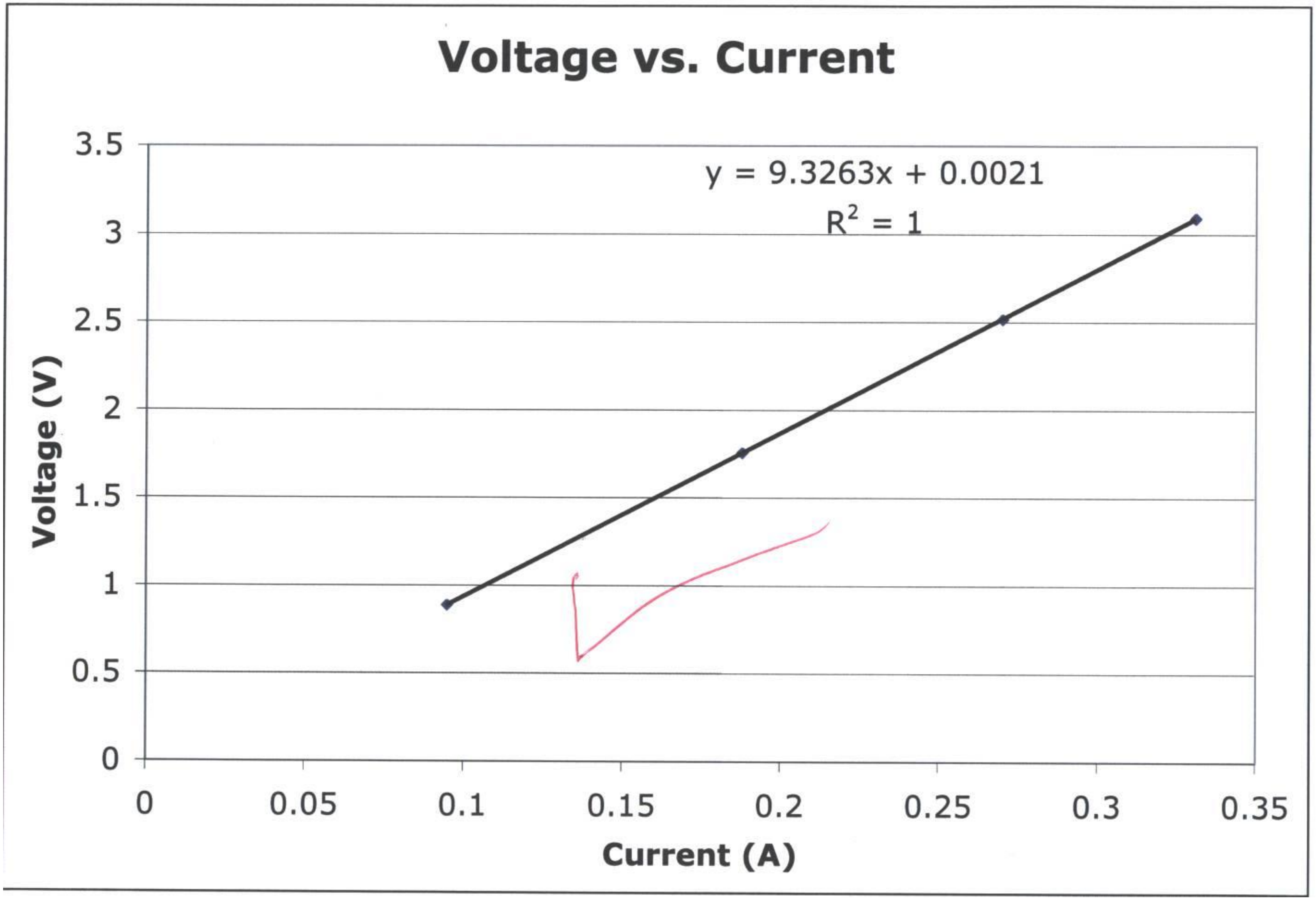
For this experiment we first used a circuit, set up by the instructor, to conduct a flow of electric current through a system that was initially opened but was then held in the closed position in order for us to record the amount of voltage and current flowing through it. We increased the voltage by increments of 1 and repeated the above steps, measuring and recording the values of current and voltage for each increment increase. We carried out five of these trials and then applied the values obtained to a graph. Obtaining the equation of the line given from the plot, we used it to determine the value of resistivity for the wire.

5/5

Data

10/10

Trial #	Voltage (Volts)	Current (A)
1	0.888	0.095
2	1.757	0.188
3	2.517	0.270
4	3.089	0.331
5	3.091	0.331


Voltage vs. Current
y = 9.3263x + 0.0021
R2 = 1
Voltage (V)
3.5
3
2.5
2
1.5
1
0.5
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
Current (A)

Results

$\Delta V = IR \rightarrow y = mx + b$

$A = \frac{\pi d^2}{4} = 3.21 \times 10^{-7}\ m^2$

$y = \Delta V$
$x = I$
$m = R_{exp}$

$d = 0.64mm$

$y = 9.3263x + 0.0021$

units?

$R = \rho\,(L / A) \rightarrow \rho_{exp} = \frac{A \times R_{exp}}{L}$

$= \frac{(3.21E^{-7}\,m^2)(9.33\,\Omega)}{10\,m}$

9/10

$\boxed{\rho_{exp} = 3.0E\text{-}7\ \Omega{*}m}$

$\%\ \text{difference} = \frac{2|(2.9E^{-7}\,\Omega\cdot m)(3.0E^{-7}\,\Omega\cdot m)|}{2.9E^{-7}\,\Omega\cdot m + 3.0E^{-7}\,\Omega\cdot m} = \boxed{3.3\ \%\ \text{difference}}$

Discussion

In this experiment we expected the resistivity of 10 meters of #22 B&S Nickel Silver wire to fall somewhere close to the actual value which is given as 2.9 x 10^-7 Ω*m. At a calculated value of 3.0E-7 Ω*m, our result were very close the actual value giving a 3.3% difference. The class as a whole obtained similar values which shows that there is definitely a level of precision that this experiment has. One limitation of our experiment was that we were only able to test one material. If we had more time, we could have tested materials of varying lengths to see if the circuit would have been as precise for these as well. If this had been done we would expect to see the same resistivity since the material is the same, but increasing resistances as we increase the length of the material. An additional limitation was that we could not change the temperature. If we tried this, we would have expected the resistivity to increase slightly along with the temperature. Sources of error were minimal due to the fact that Data Studio was used to create the graphs. However, not holding the circuit in the completely closed position would have probably made the current and voltage smaller in magnitude.

5/5

Conclusion

By far this has been our most accurate experiment. Due to the ~~quality and~~ calibration of the measuring device we determined the value of ρ_{exp} to be 3.0E-7 Ω*m, a value that only had a percent difference of 3.3%. With such a high level of accuracy, this experiment has confirmed that Ohm's law is valid because it shows the relationship between voltage, current and resistance.

4/4

Reference

1. Walker, James S., *Physics*, 2001 2nd edition. (Chapter 21)