Flipping Physics Lecture Notes:

Graphing Resistivity

https://www.flippingphysics.com/graphing-resistivity.html

Given a length of nichrome wire and a variable power supply which displays both current and electric potential difference, what data would you need to collect and what would need to go on the axes of a graph such that the resistivity of nichrome would be the slope of the best-fit line of the data?

Let's start with Ohm's Law and solve for resistance and we also have an equation for resistance in terms of resistivity which we can set equal to one another.

$$\Delta V = IR \Rightarrow R = \frac{\Delta V}{I} = \frac{\rho L}{A}$$

Then we remove all variables from the denominators. We know have: $\Delta V A = \rho (IL)$

Comparing that to the slope intercept form equation for a line: $y = mx + b$

And you can see what variables go on the y and x axes:

$$\Rightarrow y = \Delta V A;\ m = slope = \rho;\ x = IL;\ b = 0$$

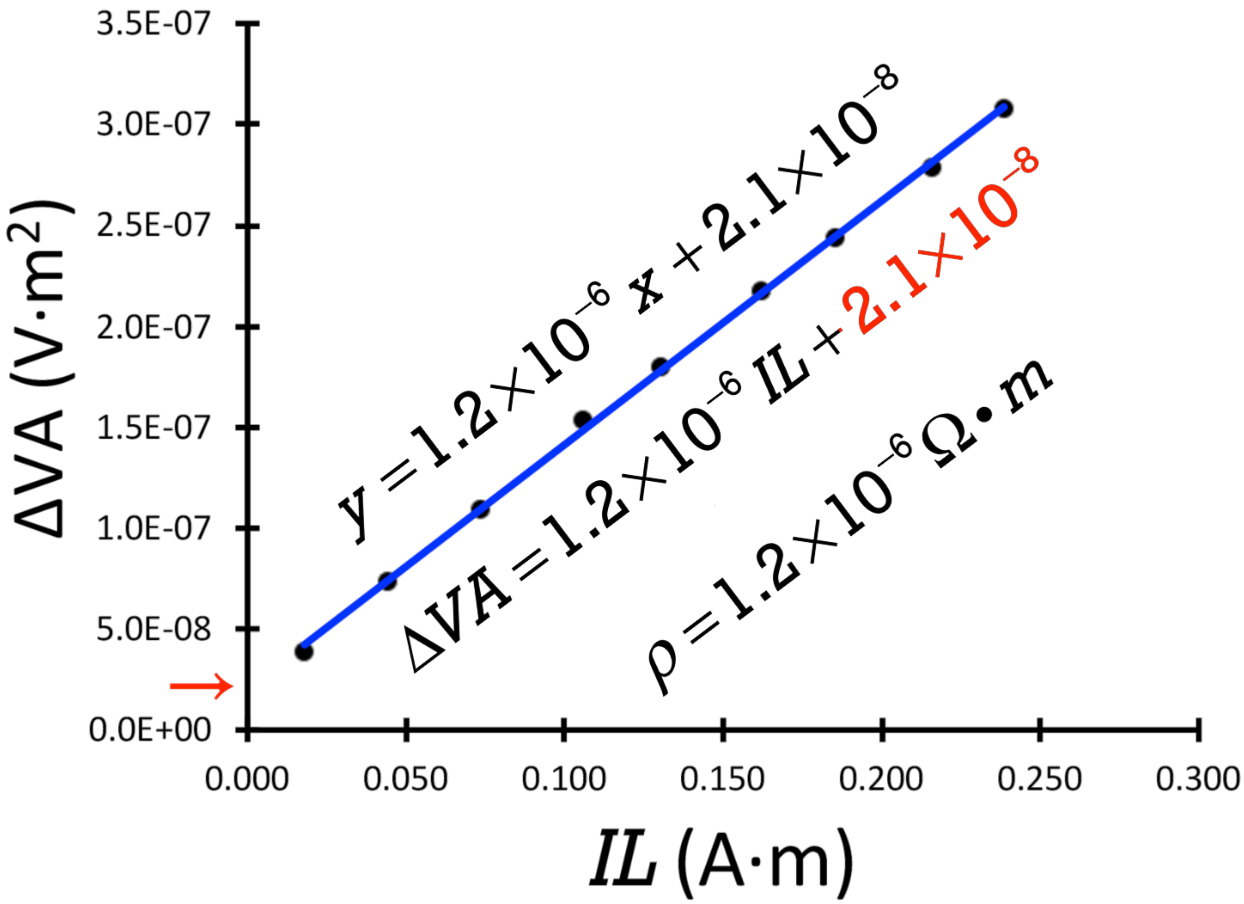
We will need the cross-sectional area of the wire. We know the wire is a 32-gauge wire. Which, according to American Wire Gauge standards, has a diameter of 0.202 mm, and a radius which is half that or 0.101 mm or 0.000101 m. Therefore, the cross-sectional area is the area of a circle or πr^2.

$$Diameter = 0.202mm \Rightarrow r = \frac{Dia}{2} = \frac{0.202mm}{2} = 0.101mm = 0.000101m$$

$$Area = \pi r^2 = \pi (0.000101)^2 = 3.20474 \times 10^{-8} m^2$$

And, if we adjust the length of the wire, then we can measure the electric potential difference across the wire and current through the wire.

ΔV (V)	Current (A)	Length (m)	ΔVA ($V \cdot m^2$)	IL (A·m)
1.2	0.36	0.050	3.8E-08	0.018
2.3	0.44	0.100	7.4E-08	0.044
3.4	0.49	0.150	1.1E-07	0.074
4.8	0.53	0.200	1.5E-07	0.11
5.6	0.52	0.250	1.8E-07	0.13
6.8	0.54	0.300	2.2E-07	0.16
7.6	0.53	0.350	2.4E-07	0.19
8.7	0.54	0.400	2.8E-07	0.22
9.6	0.53	0.450	3.1E-07	0.24



The resistivity we get from our experiment is roughly 1.2 x 10^{-6} Ω·m, which is right in the range we expect because the published value for the resistivity for nichrome at 20°C is in the range 1.0 – 1.5 x 10^{-6} Ω·m.[1]

Notice that b, the y-intercept, does not actually work out to be zero. It ends up being a small, positive number. That is because our solution assumes the wires we use in the experiment have zero resistance. The wires do have a small amount of resistance, which causes the y-intercept to have a small, positive number.

Another item to note is that I purposefully reduced the electric potential difference as the length of the wire was reduced. This is because resistivity of conductors increases with temperature. I did not want the nichrome wire to heat up too much during the experiment.

[1] https://hypertextbook.com/facts/2007/HarveyKwan.shtml