Lab 5: Resistance

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1 Data

Table 1: Data for Red Colour: Measurements of length, area, voltage, current, and resistivity

Length (m)	Area (m^2)	Voltage (V)	Current (A)	Resistivity (Ω)
0.082	9.08×10^{-4}	2.0	0.0167	1.33
0.059	9.08×10^{-4}	1.2	0.0167	1.11
0.034	9.08×10^{-4}	0.6	0.0167	0.959
0.034	6.61×10^{-4}	0.7	0.0460	0.296
0.018	6.61×10^{-4}	0.4	0.0460	0.319
0.007	6.61×10^{-4}	0.2	0.0460	0.411

Table 2: Data for Blue Colour: Measurements of length, area, voltage, current, and resistivity

Length (m)	Area (m^2)	Voltage (V)	Current (A)	Resistivity (Ω)
0.091	9.08×10^{-4}	2.4	0.0170	1.41
0.059	9.08×10^{-4}	1.5	0.0170	1.36
0.034	9.08×10^{-4}	0.8	0.0170	1.26
0.031	6.61×10^{-4}	0.7	0.0460	0.324
0.017	6.61×10^{-4}	0.5	0.0460	0.423
0.008	6.61×10^{-4}	0.1	0.0460	0.180

2 Uncertainty

As we deform both of the Play-doh, we seem to notice a slight change in the voltage. It seems to fluctuate around ± 0.2 V from the original voltage. This number of 0.2 seems to stay consistent throughout area, length, and Play-doh colour. It does in fact impact the uncertainty in our experiment, as now we have an additional value we are uncertain about, increasing the error of our final value.

3 Statistics

As outlined in section 6.1, we know that our mean μ is given by the formula:

$$\mu_{\text{red}} = \frac{1}{N}\sum_{i=1}^{N} x_i = 0.736\,\Omega$$

$$\mu_{\text{blue}} = \frac{1}{N}\sum_{i=1}^{N} x_i = 0.825\,\Omega$$

where N is the number of measurements and x_i represents each individual measurement.

We also know that the standard deviation is given by:

$$\sigma_{\text{red}} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_{\text{red}})^2} = 0.449$$

$$\sigma_{\text{blue}} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu_{\text{blue}})^2} = 0.573$$

where N is the number of measurements, x_i represents each individual measurement, and mu represents the means found above.

This also gives us our mean error from the formula below:

$$\delta\mu_{\text{red}} = \frac{\sigma_{\text{red}}}{\sqrt{N}} = \frac{0.449}{\sqrt{6}} \approx 0.183$$

$$\delta\mu_{\text{blue}} = \frac{\sigma_{\text{blue}}}{\sqrt{N}} = \frac{0.573}{\sqrt{6}} \approx 0.234$$

4 Comparison

When straight up using the mathematical wonder of subtraction, we get:

$$\Delta\mu = \mu_{\text{red}} - \mu_{\text{blue}} = 0.736\,\Omega - 0.825\,\Omega = -0.089\,\Omega$$

However, when using our uncertainties, we can propogate the error!

$$\delta\Delta\mu = \sqrt{(\delta\mu_{\text{red}})^2 + (\delta\mu_{\text{blue}})^2} = \sqrt{(0.183)^2 + (0.234)^2} \approx 0.294$$

Therefore, the difference in means with propagated error is:

$$\mu_{\text{red}} - \mu_{\text{blue}} = -0.089\,\Omega \pm 0.294\,\Omega$$

Since our difference in means is actually between one propogated error interval, we can say that there is good agreement between the means. In other words we can say that the means are pretty similar and there isn't much of a difference.

References

[1] Department of Physics. *PHYS 126 Lab Manual.* University of Alberta, 2025.

[2] TA assisted with the lab, and provided guidance on the data collection and analysis.

[3] Lab partner Morgann Reinhart assisted with the data collection and analysis.