Lab Experiment #4:

Wheatstone Bridge

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PHYS 200BL
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Data

Measurement of R_1

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
R_s	15Ω	50Ω	70Ω	85Ω	30Ω
x (cm)	68.1 cm	41.6 cm	29.7 cm	35.8 cm	50.1 cm
R_1	32Ω	36Ω	30Ω	47Ω	30Ω

Direct multimeter measurement: 59.8Ω

Measurement of R_2

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
R_s	15Ω	30Ω	50Ω	70Ω	23Ω
x(cm)	63.9 cm	45.6 cm	33.5 cm	26.6 cm	52.2 cm
R_2	27Ω	25Ω	25Ω	25Ω	25Ω

Direct multimeter measurement: 28.4Ω

Data Reduction

	x	R	Δx	ΔR
R_1	50.1 cm	30Ω	0.1 cm	0.1Ω
R_2	52.2 cm	25Ω	2.2 cm	2.3Ω

Lab Questions

1. Using formula 4.5 and "percent difference" formula to calculate percent uncertainty:
   a. $x = 10 \pm 0.1$ cm:

$$100\left[\frac{|40.1\frac{100}{(100-9.9)^2} - 39.9\frac{100}{(100-10.1)^2}|}{\frac{40.1\frac{100}{(100-9.9)^2}+39.9\frac{100}{(100-10.1)^2}}{2}}\right] = 0.56\%$$

   b. $x = 50 \pm 0.1$ cm

$$100\left[\frac{|0.1\frac{100}{(100-49.9)^2} - 0.1\frac{100}{(100-50.1)^2}|}{\frac{0.1\frac{100}{(100-49.9)^2}+0.1\frac{100}{(100-50.1)^2}}{2}}\right] = 0.80\%$$

   c. $x = 95 \pm 0.1$ cm

$$100\left[\frac{|45.1\frac{100}{(100-94.9)^2} - 44.9\frac{100}{(100-95.1)^2}|}{\frac{45.1\frac{100}{(100-94.9)^2}+44.9\frac{100}{(100-95.1)^2}}{2}}\right] = 7.55\%$$

2. If the 2 volts from the power supply were to be increased to 6 volts, I would expect the galvanometer to be much more sensitive to minute movements in the position of the "split" of the wire of the potentiometer (x vs $100 - x$), since given the same amount of resistance from the components of the circuit, there would be more current flowing (following from Ohm's Law). Since the galvanometer reads in μA,

we would need to be careful in using the "K-key" to increase the accuracy of the reading. to avoid overloading the galvanometer. I might also expect the wire of the potentiometer to get quite hot.

3. Depressing the K-key of the galvanometer greatly increased the precision of the reading once we were in the "ballpark" of a good $x-$value for an accurate reading. However, this increased sensitivity provided some concern when the distance to a proper x was increased, as the instrument is apparently quite vulnerable to current in an "unbalanced" circuit.
4. Fluctuations in the voltage provided by the power supply will result in a fluctuating current reading from the galvanometer, and will make it harder to pinpoint a "balance" point for the $x-$position of the right and left sides of the split potentiometer resistance.
5. The contact point should be moved towards the right, decreasing the x distance.
6. The measured and observed values for R_2 are quite close, and the percent difference is quite small:

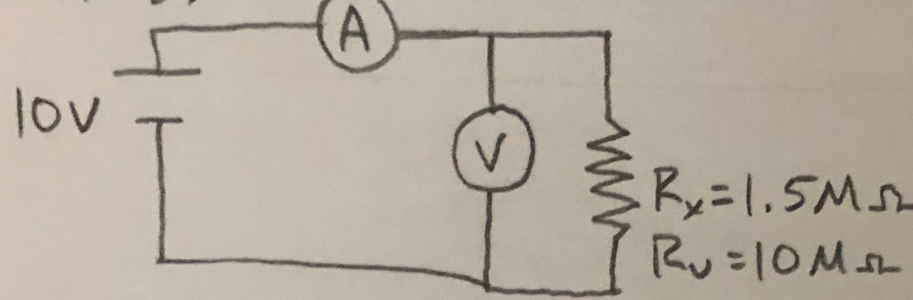
$$100\left[\frac{|25\Omega - 28.4\Omega|}{\frac{25\Omega+28.4\Omega}{2}}\right] = 8.7\%$$

However, the results from observed vs. direct measurements of R_1 are inconclusive, given the large percent of error:

$$100\left[\frac{|30\Omega - 59.8\Omega|}{\frac{30\Omega+59.8\Omega}{2}}\right] = 66\%$$

Data sheet + Quiz

Quiz:



$$V = IR$$

$$\frac{V}{R} = I \rightarrow R = \frac{R_x R_v}{R_x + R_v} \rightarrow \frac{V(R_x + R_v)}{R_x R_v} = I$$

$$I = \frac{10V(11.5M\Omega)}{15M\Omega}$$

$$I = 7.7\ A$$

4.7 Data sheet

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Data

Measurement of the resistance R_1.

Iterate as described in section 4.5

	1	2	3	4	5
R_s	15 Ω	50 Ω	70 Ω	85 Ω	30 Ω
x (cm)	68.1 cm	41.6 cm	29.7 cm	35.8 cm	50.1 cm
R_1 (eq 4.4)	32 Ω	36.5 Ω	30 Ω	47 Ω	30 Ω

Direct measurement of the resistance with the multi-meter:

R_1	59.8 Ω	±	

Measurement of the resistance R_2

Iterate as described in section 4.5

	1	2	3	4	5
R_s	15 Ω	30 Ω	50 Ω	70 Ω	23 Ω
x (cm)	63.9 cm	45.6 cm	33.5 cm	26.6 cm	52.2 cm
R_2	27 Ω	25 Ω	25 Ω	25 Ω	25 Ω

Direct measurement of the resistance with the multi-meter:

R_2	28.4	±	

Data Reduction

Use the resistance values that you found closest to the center of the slide wire, *i.e.* closest to $x = 50$ cm, record these below, and calculate the uncertainty in R, ΔR, using equation 4.5

	x	R	Δx	ΔR
R_1	50.1 cm	30 Ω	0.1 cm	0.1 Ω
R_2	52.2 cm	25 Ω	2.2 cm	2.3 Ω