Lab 2: Non-Ideal Sources

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ECEN 214-502

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Procedure

Task 1:

1. Use your AA battery as the voltage source of the circuit.
2. Measure the voltage of the AA battery using the voltmeter and record the data. (in parallel)
3. Now connect a resistor to the circuit that ranges from 50 to 2000 ohms.
4. Measure the voltage of the resistor using a voltmeter (voltmeter in parallel with the resistor) and write the measurement in your lab notebook.
5. Disconnect the resistor and then measure the resistance of it using the voltmeter. (voltmeter in parallel with the resistor).
6. Repeat steps 2-5 with various (at least 7 times) resistors/resistance.

Task 2:

1. Repeat task 1 with the other battery in your kit
2. Repeat task 1 using both batteries in series.

Data Tables

Task 1: Battery 1 (1.616 V)

R (expected)	Resistance (Ohms)	Voltage of Resistor (V)
100	101	1.552
200	201	1.597
1000	978	1.61
2000	1957	1.612
3000	2939	1.612
2200	2156	1.602
1200	1178	1.609

Task 2: Battery 2 (1.532 V)

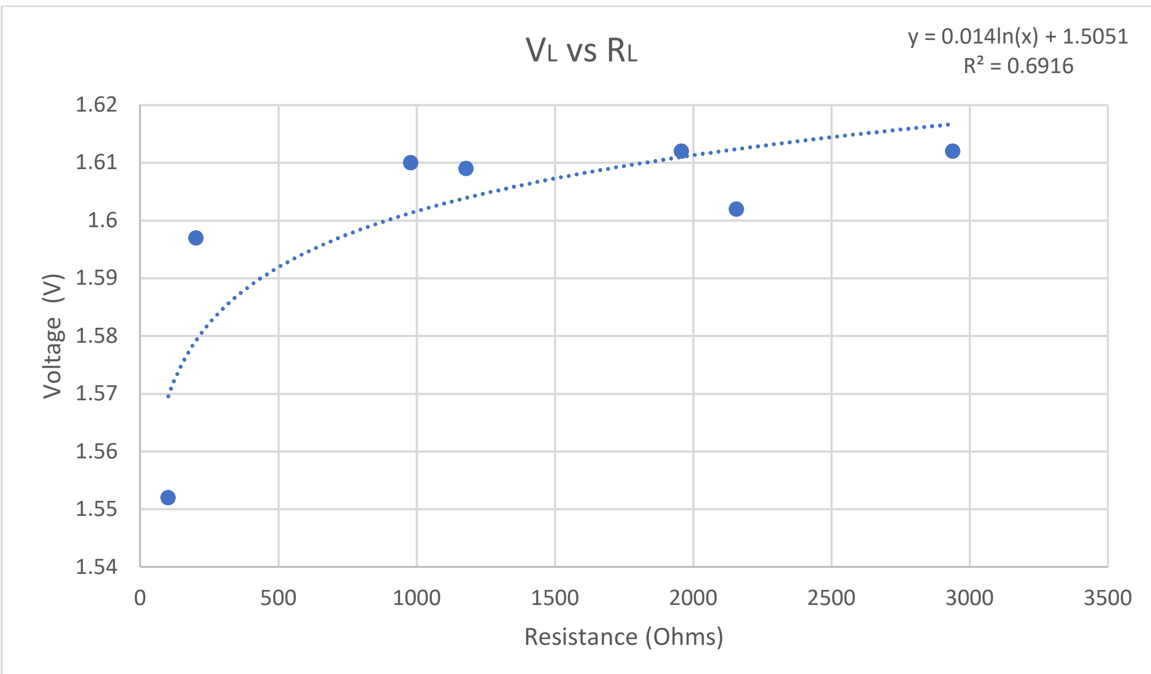
R (expected)	Resistance (Ohms)	Voltage of Resistor (V)
100	103	1.487
200	201	1.492
1000	1101	1.501
2000	1982	1.511
2100	2101	1.523
2200	2189	1.525
1200	1220	1.508

Task 2: Battery 1 and 2 (3.148 V)

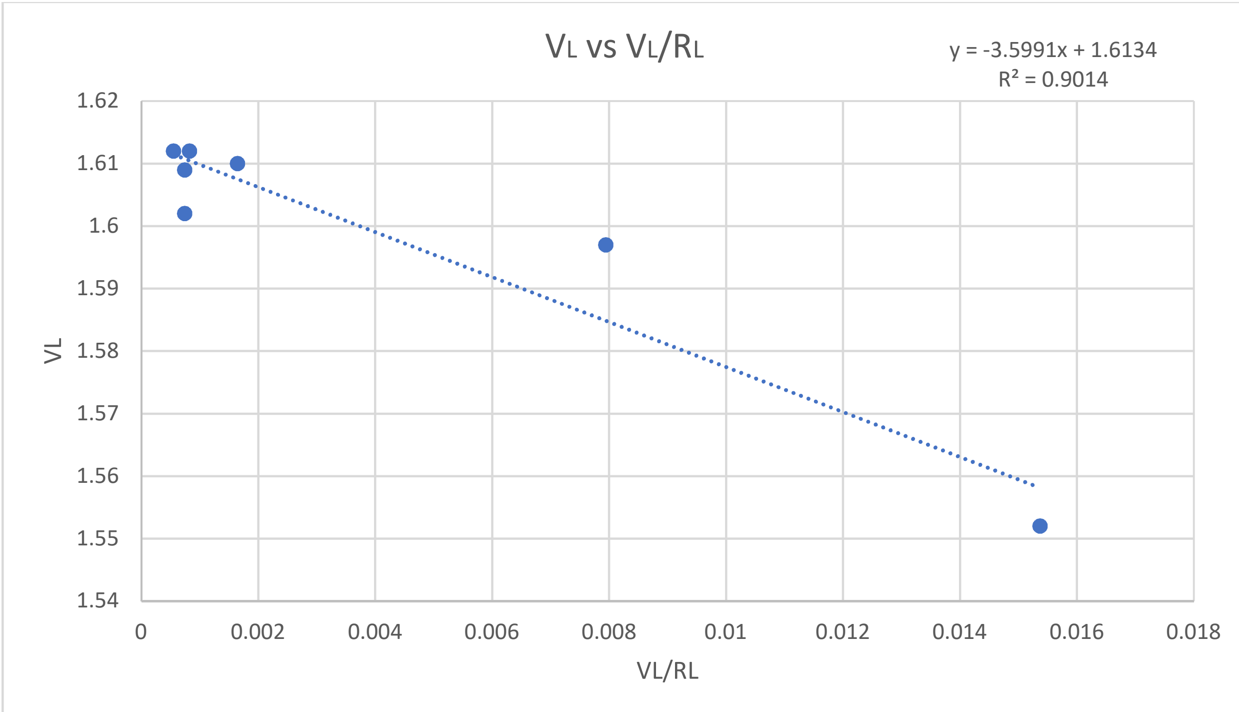
R (expected)	Resistance (Ohms)	Voltage of Resistor (V)
100	99.4	3.023
200	202.4	3.048
1000	974.6	3.088
2000	1969.1	3.095
3000	2932	3.1
2200	1175	3.099
1200	2150	3.102

Graphs

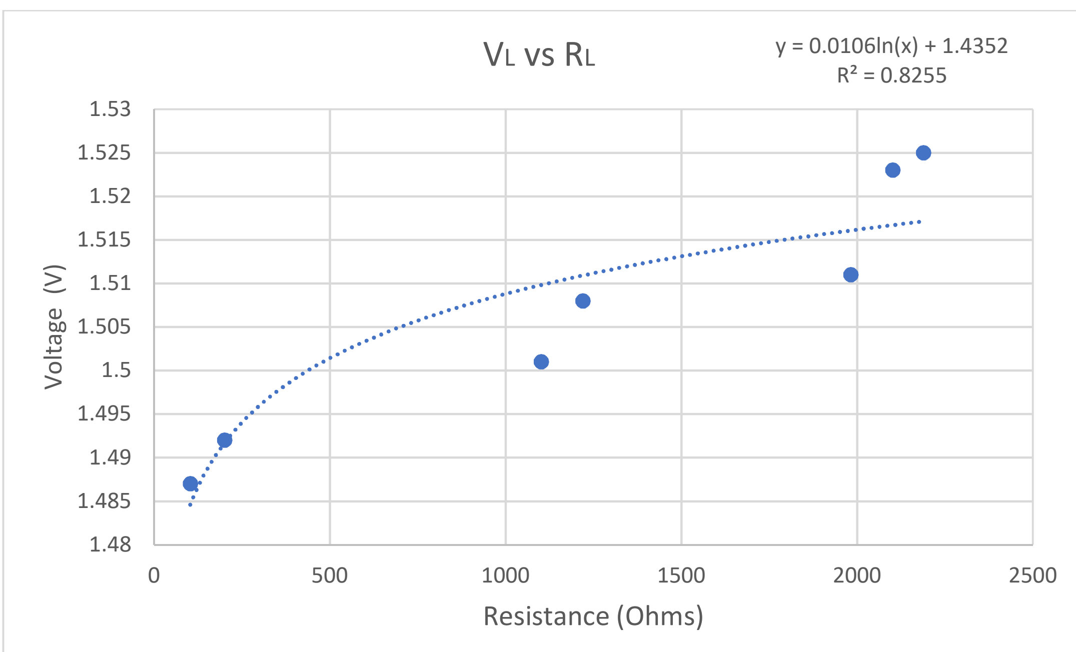
Task 1: Battery 1 (1.616 V) Non-Linear



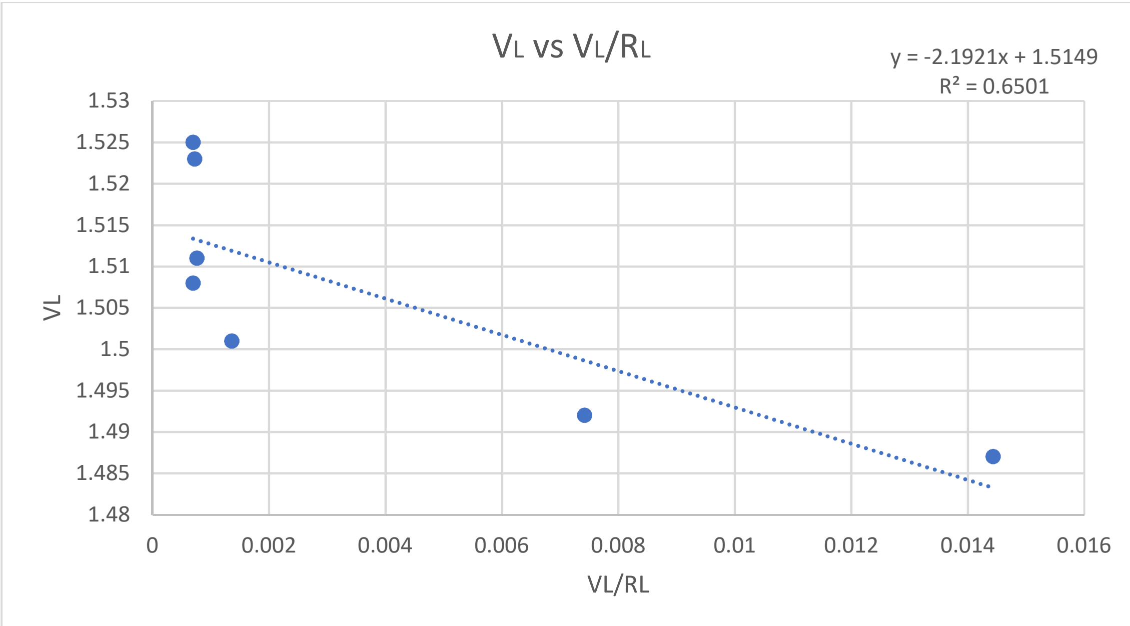
Task 1: Battery 1 (1.616 V) Linearized



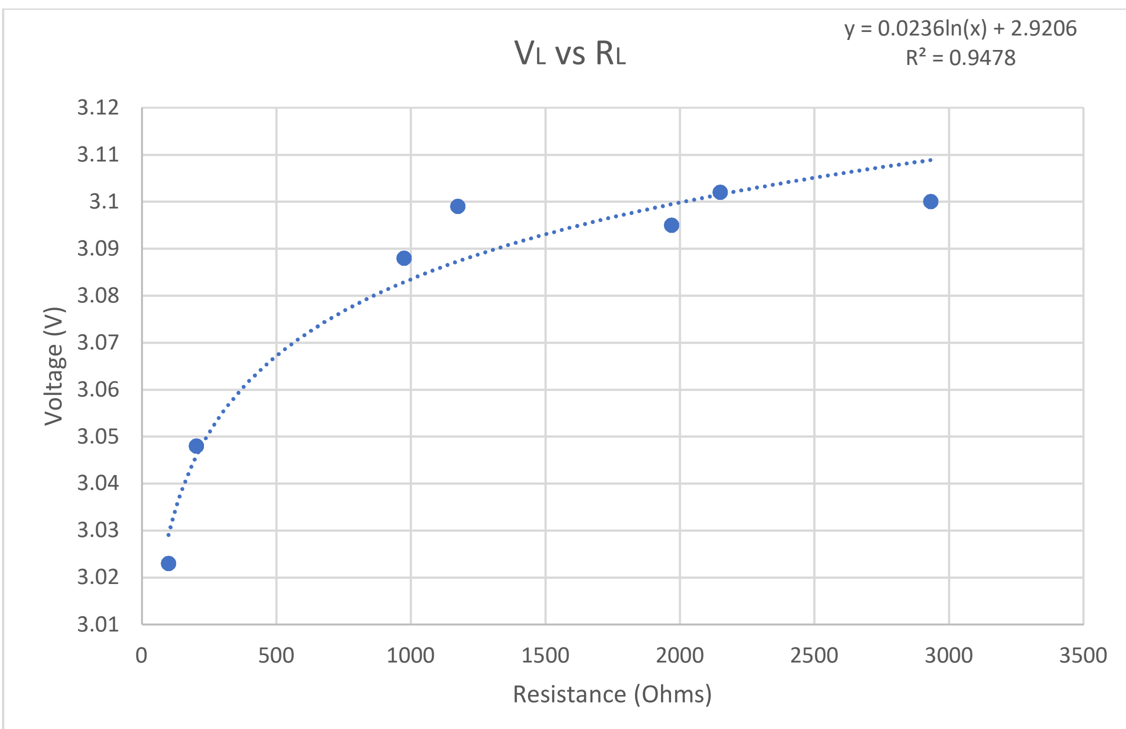
Task 2: Battery 2 (1.532 V) Non-Linear



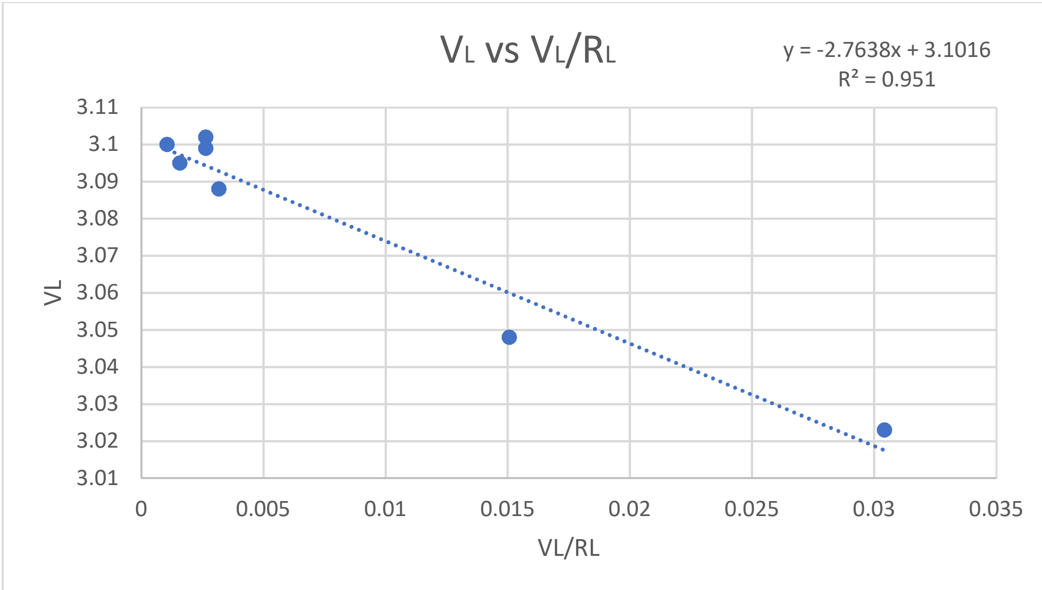
Task 2: Battery 2 (1.532 V) Linearized



Task 2: Battery 1 and 2 (3.148 V) Non-Linear



Task 2: Battery 1 and 2 (3.148 V) Linearized



Simple Calculations:

$$V_L = V_s \frac{R_L}{R_L + R_s}$$

$$V_L = V_S - \frac{V_L}{R_L} R_S$$

V_S is the y-intercept

$-R_S$ is the slope

Graphed V_L vs $\frac{V_L}{R_L}$ to solve for both V_S and R_S

$$\%Error_1 = \left|\frac{Actual - Expermental}{Actual}\right| \times 100$$

V_S error for Battery 1:

$$\left|\frac{1.616 - 1.6134}{1.616}\right| \times 100 = \ 0.16\%$$

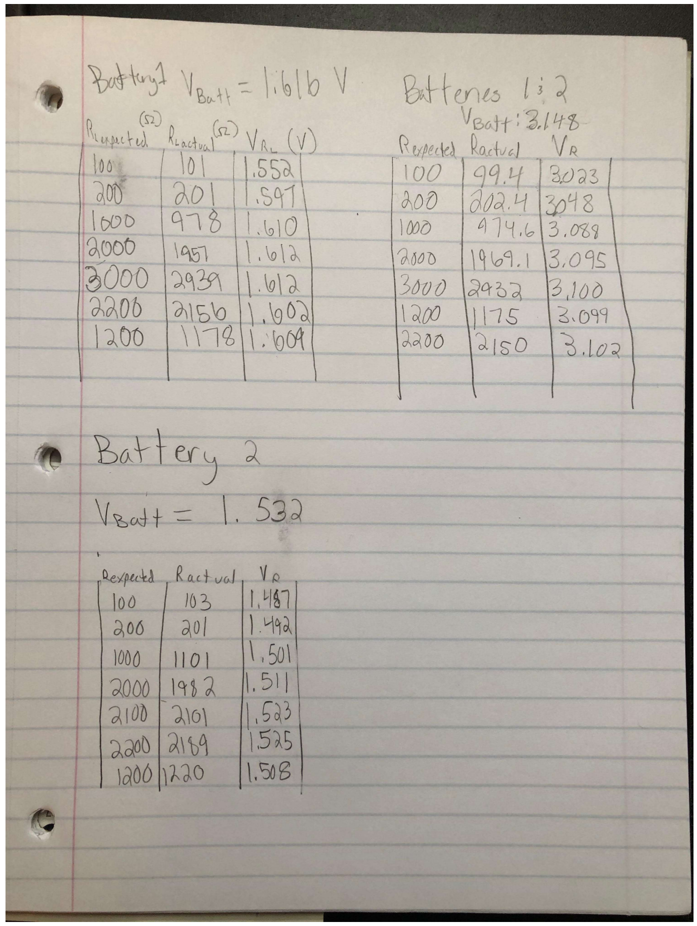
V_S error for Battery 2:

$$\left|\frac{1.532 - 1.5149}{1.532}\right| \times 100 = \ 1.12\%$$

V_S error for Battery 1 and 2 combined:

$$\left|\frac{3.148 - 3.1016}{3.148}\right| \times 100 = \ 1.47\%$$

Screenshot



Battery1 $V_{Batt} = 1.616$ V

$R_{L\,expected}$ (Ω)	$R_{L\,actual}$ (Ω)	V_{R_L} (V)
100	101	1.552
200	201	1.597
1000	978	1.610
2000	1957	1.612
3000	2939	1.612
2200	2156	1.602
1200	1178	1.609

Batteries 1 : 2

V_{Batt} : 3.148

$R_{expected}$	R_{actual}	V_R
100	99.4	3.023
200	202.4	3.048
1000	974.6	3.088
2000	1969.1	3.095
3000	2932	3.100
1200	1175	3.099
2200	2150	3.102

Battery 2

$V_{Batt} = 1.532$

$R_{expected}$	R_{actual}	V_R
100	103	1.487
200	201	1.492
1000	1101	1.501
2000	1982	1.511
2100	2101	1.523
2200	2189	1.525
1200	1220	1.508

Discussion

Overall, the experiment was a success. Both our measured voltage of the batteries and calculated voltage were almost equal with no greater than a 1.5% difference, so there was around 1.5% or less error within our experimentation. However, this was calculated with the experimental error formula, we hadn't accounted for the accuracy of our graphs, which would be the correlation. For task 1, the linearized graph had a R^2 value of 0.9014. For task 2, the graphs had correlation values of 0.6501 and 0.951. Anything close to $R^2 = 1$ is considered great data. In our case, we had 2 graphs with good data and 1 with bad data. If there was no error within the equipment used to measure, all our graphs should have a R^2 of 1 because $V_L = V_S - \frac{V_L}{R_L} R_S$ is a proven formula. Thus, there were some errors with our measurements or unaccounted for variables that lead our data to not have a perfect correlation. Even though our graphs aren't perfect they are accurate to our measure voltage of the batteries. In hindsight, we could improve the estimates if we knew the values of the resistance of the wires we used to setup the circuit, then we could account for some extra resistance that isn't from the voltage source.

Conclusion

In this lab, we learned how to setup a simple circuit with resistors and use the voltmeter to measure resistance. We also learned to linearize data given a formula. Most important of all, we proved that voltages sources produce their own internal resistance.