ISIM Lab No. 3 Report: Concerning Strain Gauges

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1 Calibration and Determining Unknown Weights

In this lab, I used a stretch-variable resistor (strain gauge) to measure the weight of a variety of washers.

After setting up my circuit, I placed four different weights at the end of my strain gauge and recorded the voltage measured across the resistor in each case. Plotting those values gave me the dark blue data-points on the below graph (see Figure 1). I then used those four point to calculate a line-of-best-fit for voltage vs. weight. The resulting line-of-best-fit was $y = 1023x - 1.65$. I used that line to calculate the approximate weight of a washer creating a 0.02V voltage difference over the strain gauge (18.81 grams, shown as a green square) and random washer creating a 0.06261V difference (62.40 grams, shown as an orange triangle) respectively.

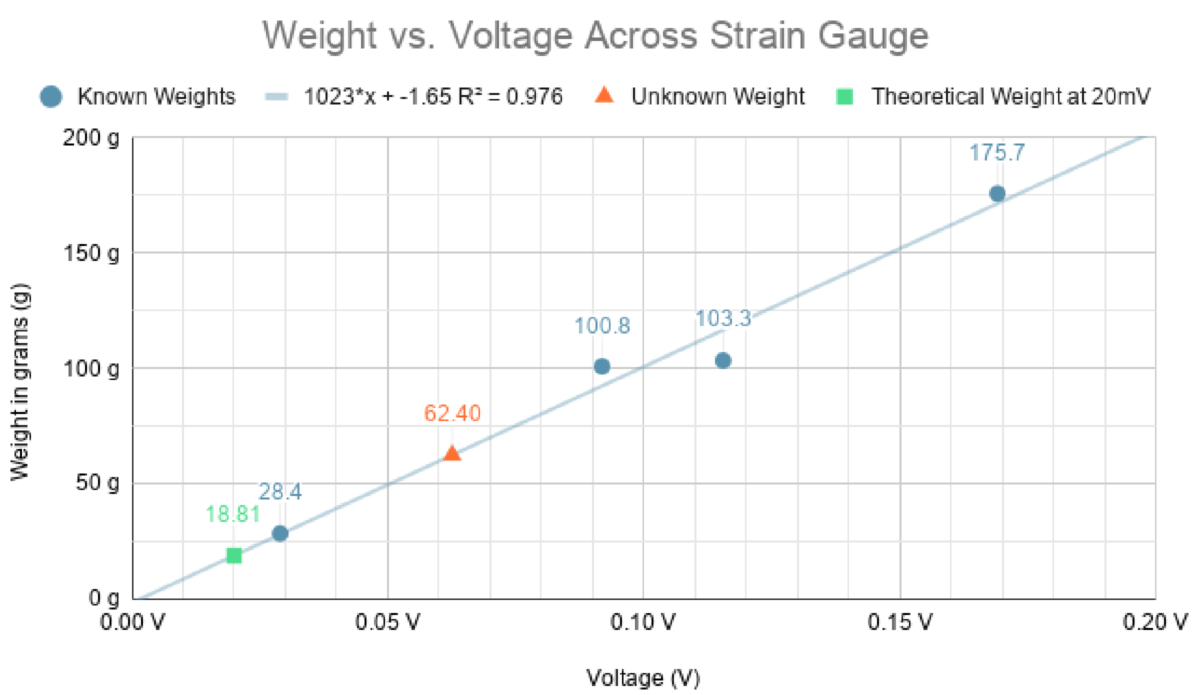

Figure 1: In this graph, voltage - the known - is displayed on the x-axis, and weight - the desired calculation - on the y-axis. I chose this orientation so that the line-of-best-fit equation ($y = 1023x - 1.65$) would give (weight) = 1023(voltage) - 1.65 naturally and thus make it easier to calculate the approximate weights of the unknown washers.

2 Analysis

2.1 Sensitivity

Scale sensitivity can be measured as $\frac{dV_{output}}{dmass_{input}}$, the reciprocal of the slope of my earlier equation $y = 1023x - 1.65$. This makes my sensitivity $\frac{1}{1023}\frac{dV_{output}}{dmass_{input}}$ or 0.0009775 volts per gram.

2.2 For a 0.02V change, what is the associated change in electrical resistance of the strain gauge?

The equations from the lab instructions about the gain from the amp give us:

$$V_{out} = V_{ref} + G(V_+ - V_-)$$

$$G = 1 + \frac{10,000\Omega}{R_G}$$

$$V_{out} = V_{ref} + \left(1 + \frac{100,000\Omega}{R_G}\right)(V_+ - V_-)$$

$$0.02 = 2.5 + \left(1 + \frac{100,000\Omega}{200\Omega}\right)(\Delta V)$$

$$\text{Non-amplified } \Delta V = 0.0049501$$

Now we can work with the circuit diagram without the amp, where Non-amplified ΔV is ΔV_{meas}.

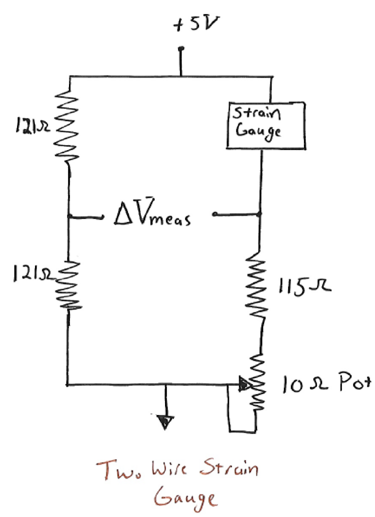

Figure 2: The circuit diagram from the lab instructions without the amplifier component. Ignoring the left side of the circuit (as it stays the same throughout the experiment) I simplify the strain gauge to R_1 and the $115\Omega + 10\Omega$ resistor and pot pair to R_2.

I can now say that:

$$\text{Non-amplified } \Delta V = V_{in}\left(\frac{R_2}{R_1 + R_2}\right)$$

$$0.0049501 = 5\left(\frac{120}{R_1 + 120}\right) \text{ so then } R_1 = 119.525$$

With no weights, $R_1 = R_2 = 120$, so $\Delta R_1 = 120\Omega - 119.525\Omega = \boxed{0.475\Omega}$