Lab 1

In [1]:
```
%matplotlib notebook
import numpy as np
import scipy as sp
import matplotlib.pyplot as plt
import scipy.optimize
import seaborn as sns
import scipy.odr as odr
import matplotlib.ticker as mticker

from IPython.display import Image
from decimal import Decimal
from astropy.modeling import models, fitting
from math import pi
```

Phys 330 – Electronics – Lab 1

Equipment, Measurements, and Voltage Dividers Equipment

- Digital multimeter (DMM)
- Analog Discovery 2
- Laptop with Waveforms installed
- Breadboard adaptor
- Large breadboard
- Components
  - 2 x 20 kΩ resistors
  - 2 x 10 kΩ resistors

Part 1 – Getting familiar with Waveforms and AD2 First measurement Follow the Anolog Discovery 2 – Getting Started Guide on the Digilent website: https://reference.digilentinc.com/learn/instrumentation/tutorials/analog-discovery-2-getting-started This will walk you through unboxing the device, installing WaveForms (if you haven't done so), and taking your first measurement. Breadboards Sparkfun has a nice tutorial on the anatomy of a breadboard: https://learn.sparkfun.com/tutorials/how-to-use-abreadboard/anatomy-of-a-breadboard Most, if not all, of the prototyping we will be doing will be on your breadboard. It will be very handy to use the breadboard breakout to connect the pins of the AD2 directly to rows on the breadboard. Set up your station like the photo on the right. Now you can use jumper wires to connect different ports of the AD2. Try repeating your "first measurement" using wires on the breadboard. Try powering the rails with the voltage supply and measure them with the voltmeter on the AD2.

In [3]:
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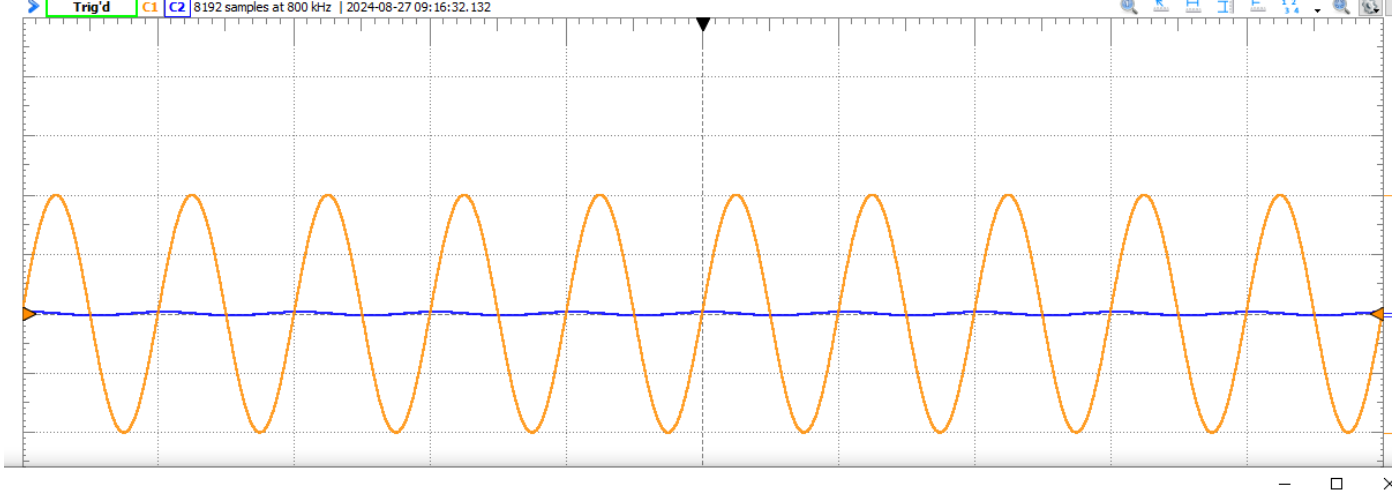
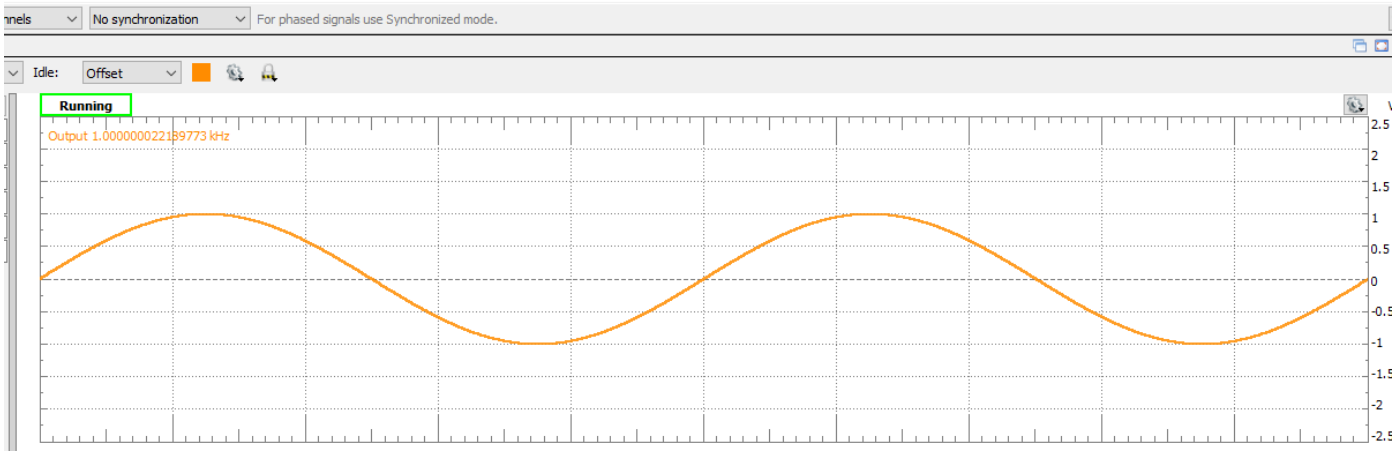
Image("pic2.png")
```

Out[3]:





Part 2 – Getting to know your DMM

Digital Multimeters are very useful tools for measuring many electronic quantities – voltage, resistance, current, even capacitance. If you like to tinker, I highly recommend getting one of your own to have around the house. They can range greatly in price, but you can get by with most household projects with a fairly inexpensive one.

DMMs come in a range of styles with varying features, and you should spend a few minutes getting to know any that you use. Most will have a dial in the center that you turn to the measurement you wish to make. Sometimes you need to place your cables or device into different ports depending on what you are measuring. Sometimes you need to choose the dial setting for the range of values you wish to measure.

Use your DMM to confirm the voltage levels of the power supplies on the AD2. Use your DMM to measure the AC voltage on a sine wave. What settings did you use for the waveform generator, and what did you measure? Does the answer make sense? If you generate a square wave with the same amplitude, what do you expect the DMM reading to be? Try it out. Were you right?

This makes sense because mathematically we should have a voltage of $\frac{\sqrt{2}}{2}$ which would numerically be 0.707 while we have a frequency of 1 khz period of 1 ms and amplitude of 1 volt

If I generatd a square wave I would expect it to be just under 1 and I am now getting 0.982 volts on the millivolt setting and 1.0 on the volt setting

In [4]:
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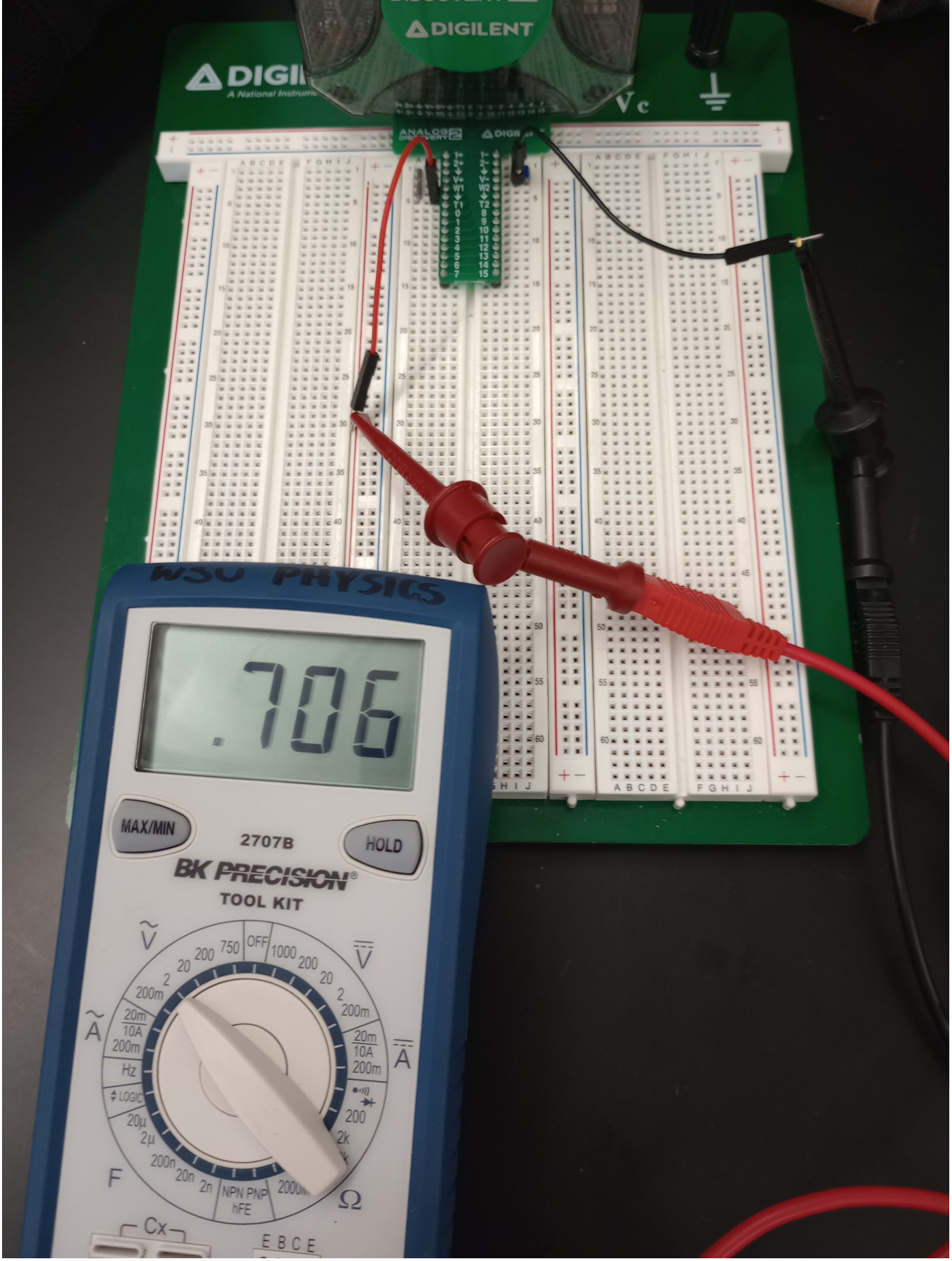
Image("pic3.jpg")
```

Out[4]:



Part 3 – Simple Voltage Divider

In [2]:
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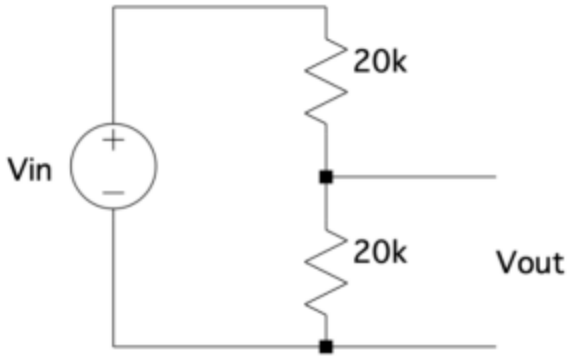
Image("pic1.png")
```

Out[2]:



We will be building the above circuit. But before you start building, predict an analytic equation relating Vout to Vin. Write your prediction down, somewhere the instructor can see when walking around the lab. Build the circuit on the breadboard. Use the power supply to apply 5V for Vin. Measure the (open circuit) output voltage using the scope ports of the AD2, or your DMM. You can see my setup on the right.

Next, attach a 10 kΩ load to the output. In other words, connect another resistor from the high end of Vout to the low end. This represents using the voltage divider to supply a voltage to a device with 10 kΩ impedance. Measure the output voltage again. Did it change? Draw and analyze the circuit diagram.

In [5]:
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Image("pic4.png")
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Out[5]:

Elements Symbol	RESISTOR 	CAPACITOR 	INDUCTOR 
Denoted by	R	C	L
Equation	$R = \frac{V}{I}$	$C = \frac{Q}{V}$	$L = \frac{V_L}{(di/dt)}$
Series	$R_T = R_1 + R_2$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$	$L_T = L_1 + L_2$
Parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$	$C_T = C_1 + C_2$	$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2}$

In [7]:
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Image("pic5.jpg")
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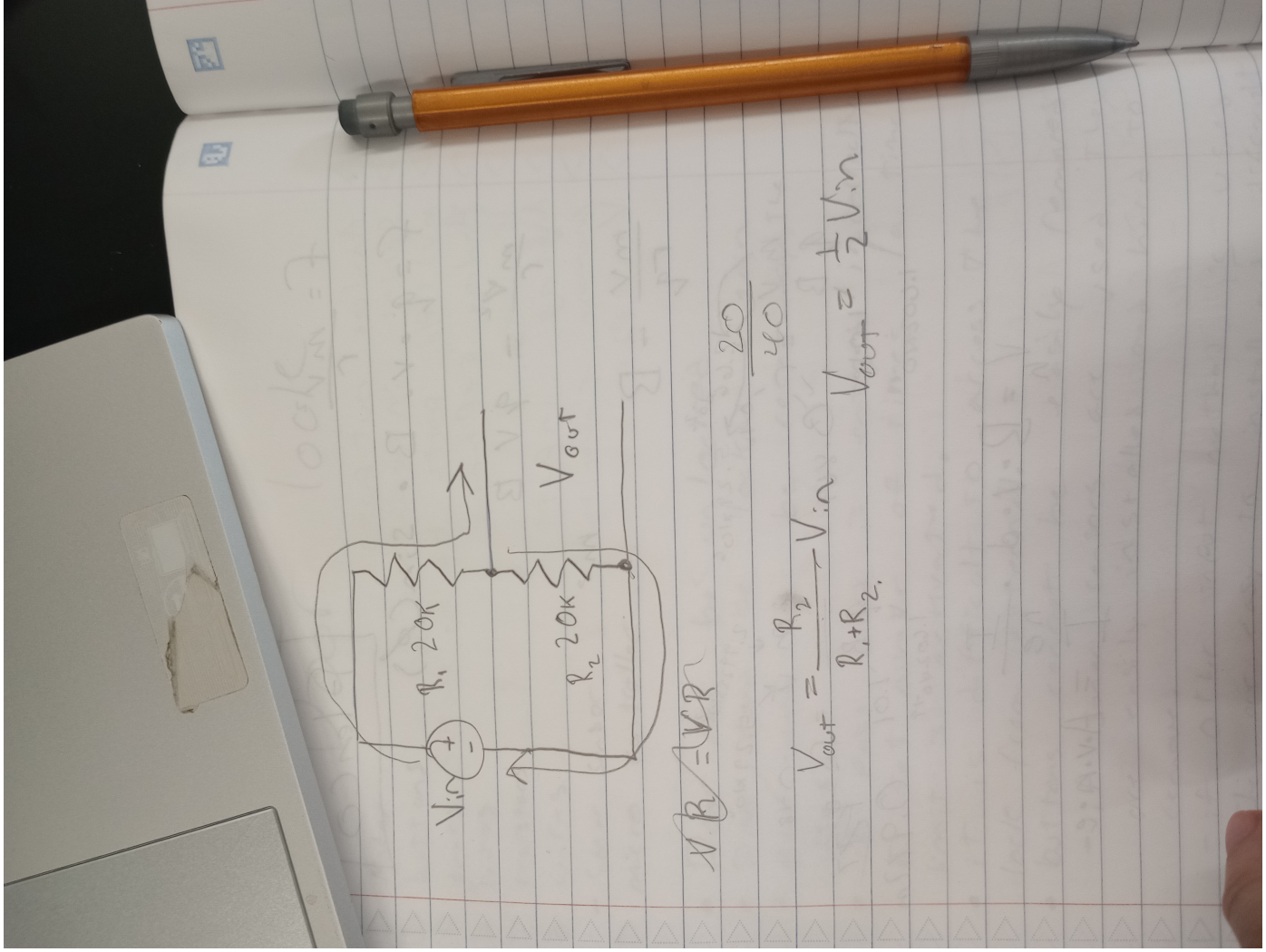
Out[7]:



My initial guess set the output voltage at half the inout voltage

In [8]:
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Image("pic6.jpg")
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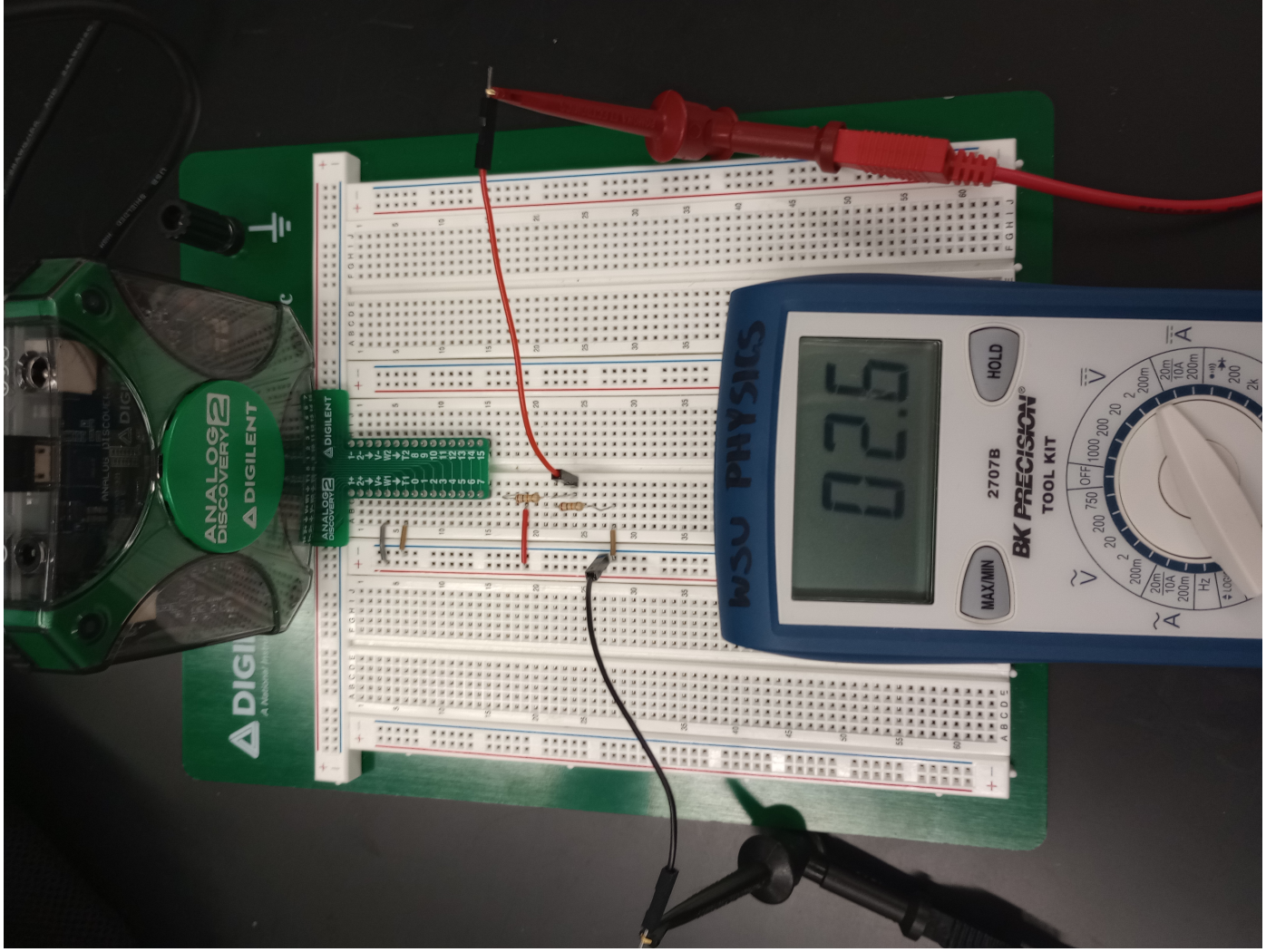
Out[8]:



This seemed to hold true in my experimentation

We can represent our voltage divider with a Thevenin equivalent circuit. For your lab report, you should use $IShortCircuit$ and $VOpenCircuit$ to calculate $VThev$ and $RThev$. Then you should predict the expected Vout with the above 10 kΩ load, using the Thevenin equivalent. If you still have time left in the lab, build your Thevenin equivalent circuit and test that you get the same open circuit voltage, short circuit current, and voltage with load attached.

I got 2.6 volts for my Thevenin Voltage so with a resistance of 10 k ohms I get a current of 26mA