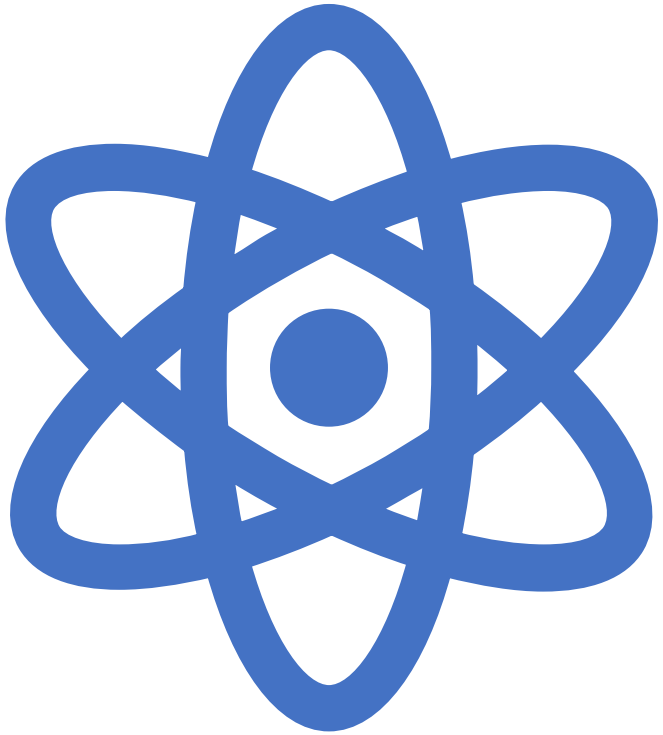


PHYS204 Final Course Project

Applied Physics with Lab

Glenn Delostrico

Introduction

- My projects involved precision, gravity and acceleration, quantities of motion, radial displacement, and hall's effect.
- Tools Used:
  - PC
  - Aruduino software
  - Mega 2560
  - ESP32
  - Breadboard
  - Ultrasonic Sensor
  - Wires
  - USB Cable
  - Ruler or Tape Measure
  - Object for free fall
  - Magnet
- What were your objectives?
- Using the components above, my objectives is to observe the natural forces of nature and record the results.

PHYS204
Module 1

Materials List

Materials List (Picture)

Mega 2560 Board

Ultrasonic sensor HC-SR04

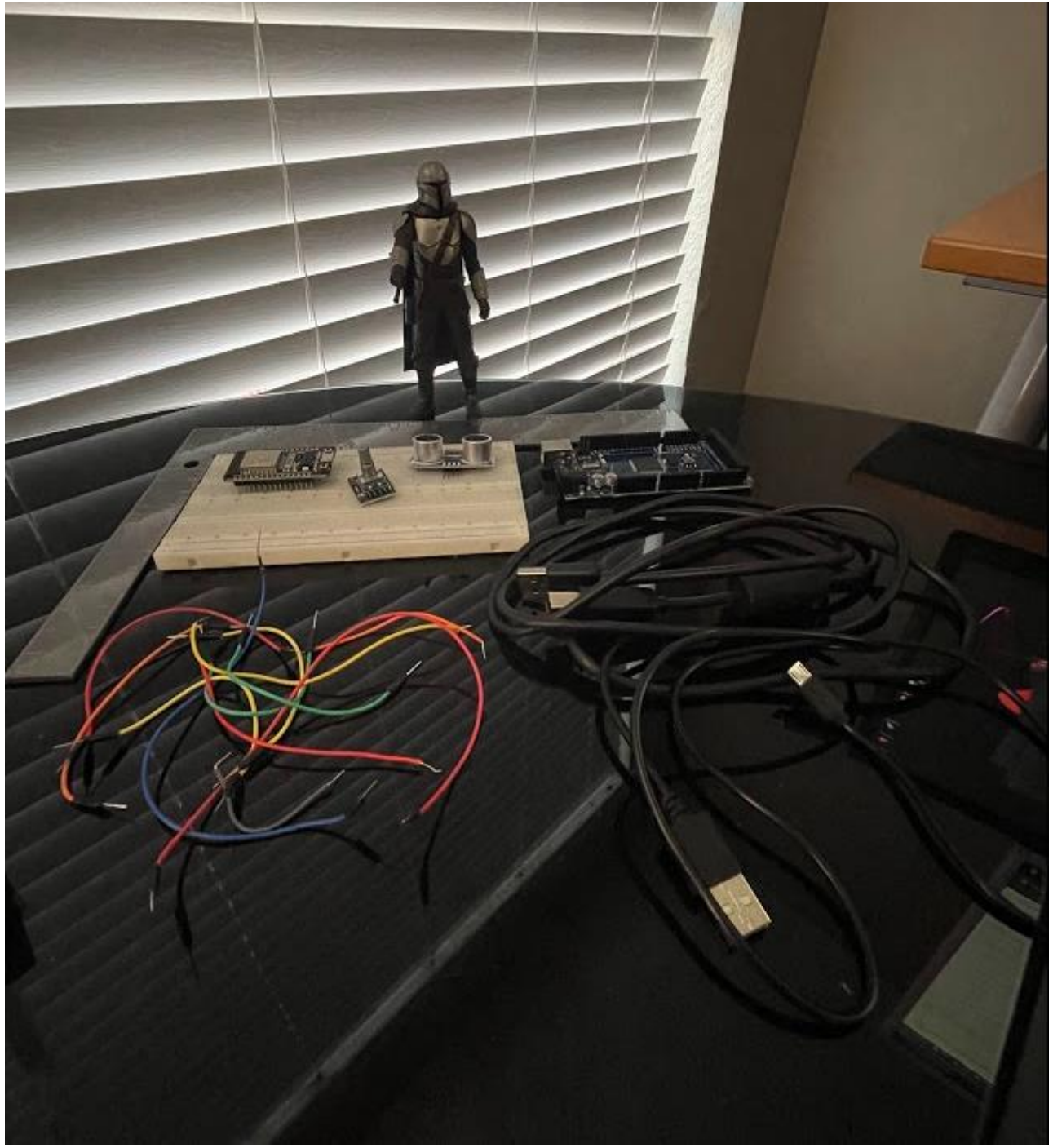
Male to Male Wires

Breadboard

USB cable

Ruler or tape measurer

Object to act as obstacle and/or undergo free-fall



Materials List (Picture)

Mega 2560 Board

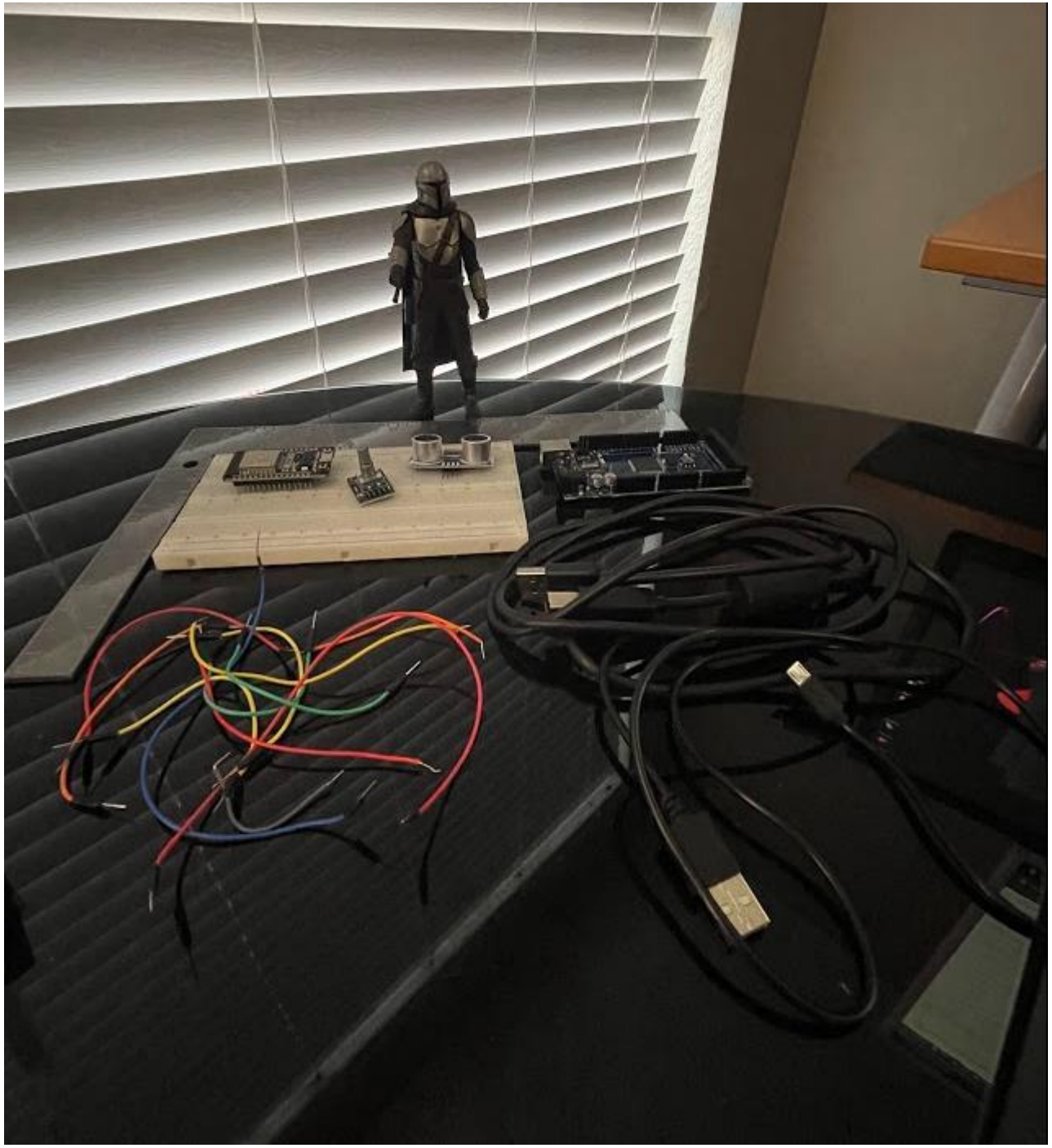
Rotary Encoder Module KY-040

Male to Female Wires

USB cable

Object to attach onto rotary encoder

Ruler or tape measurer



Materials List (Picture)

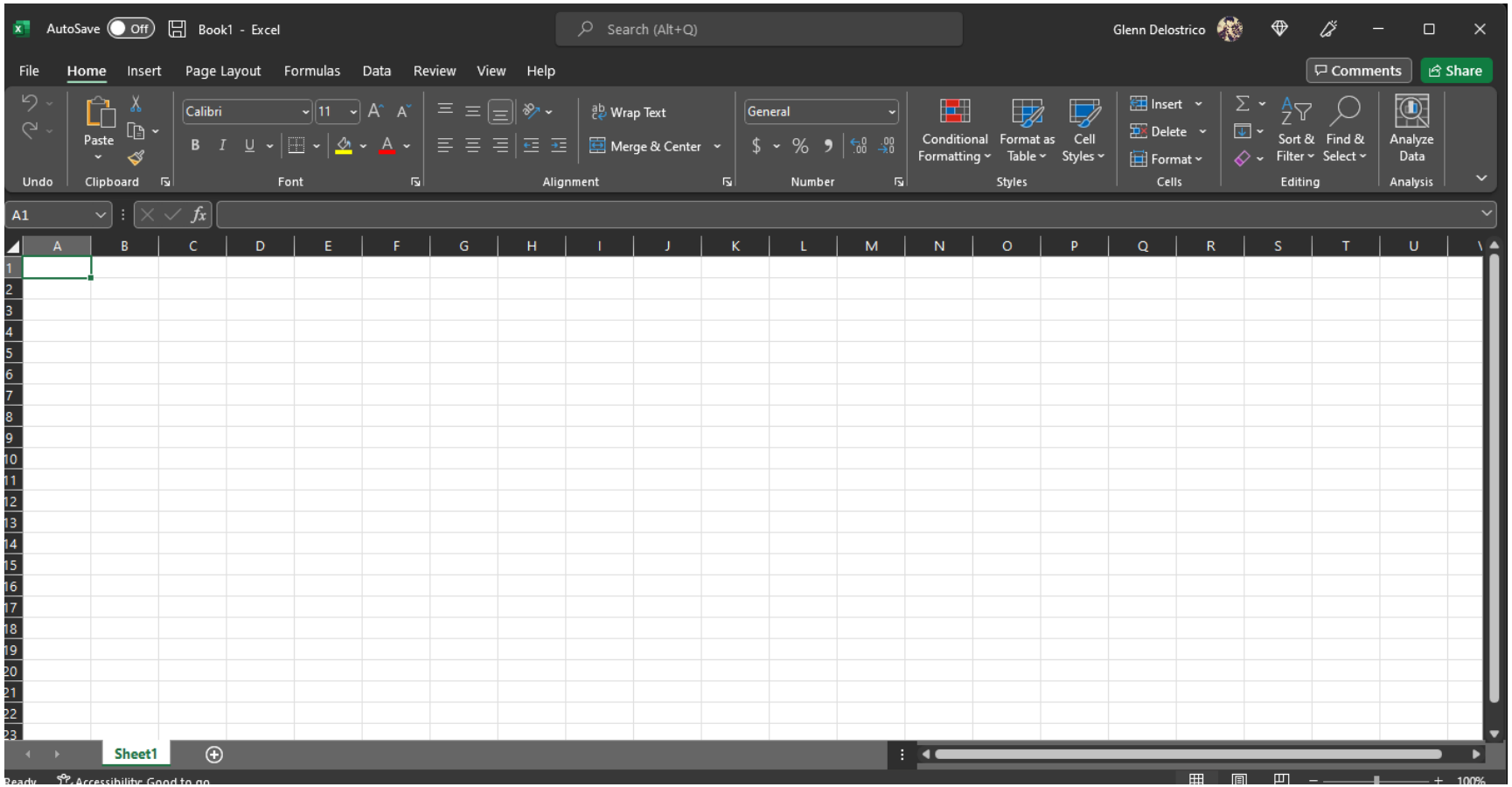
ESP32 microprocessor

Micro-USB to USB cable

Magnet

Required Software (screenshot)

Microsoft Excel installed and running on your computer



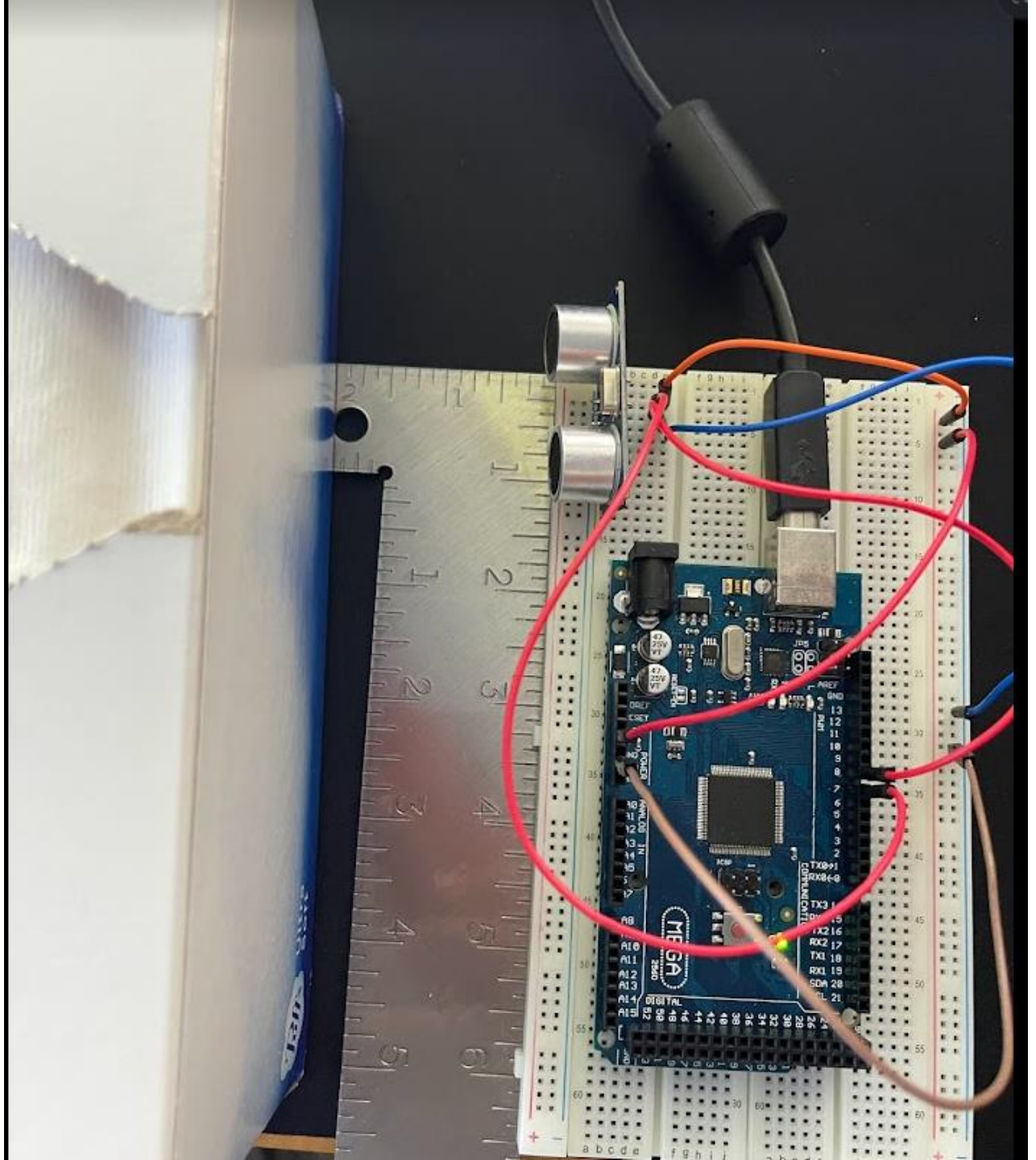
PHYS204
Module 2

Precision of the Ultrasonic Sensor

Experimental Set-up (Picture)

Materials List:

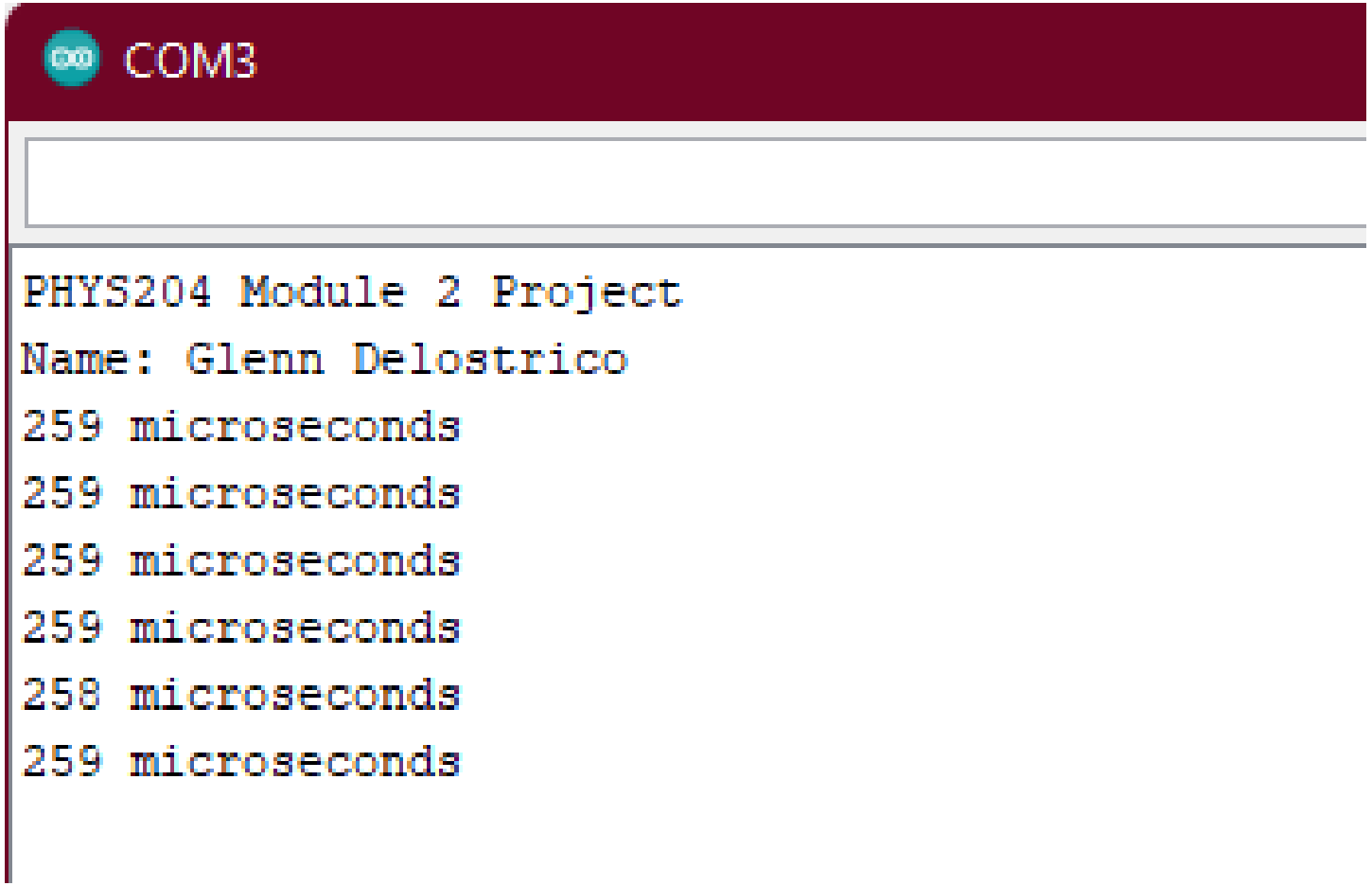
- Mega 2560 Board
- Ultrasonic sensor HC-SR04
- Male to Male Wires
- Breadboard
- Ruler or tape measurer
- Object to act as obstacle



Raw Data (Screenshot)

Screenshot of Serial Monitor from Arduino IDE showing raw data.

Must include your name displayed in the serial monitor.



Data Collection

Trial	Ruler Distance (cm)	Total Roundtrip Distance (m)	Time from Serial Monitor (microseconds)	Roundtrip time (s)	Velocity = distance/time (m/s)
1	2	.02	259	.000259	77.22
2	4	.04	649	.000649	61.63
3	6	.06	862	.000862	69.61
4	8	.08	1194	.001194	67
5	10	1	1540	.001454	64.94

Data Analysis

- Average velocity from table

$$v_{avg} = \frac{v_1 + v_2 + v_3 + v_4 + v_5}{5} = 68.08\ m/s$$

- Percent difference where $v_{sound} = 343\ m/s$

$$Percent\ difference\ = \frac{|v_{avg} - v_{sound}|}{v_{sound}} \times 100\% = -80.1519\%$$

Note: Use meters and seconds for all calculations. Show the appropriate units for measured and calculated values

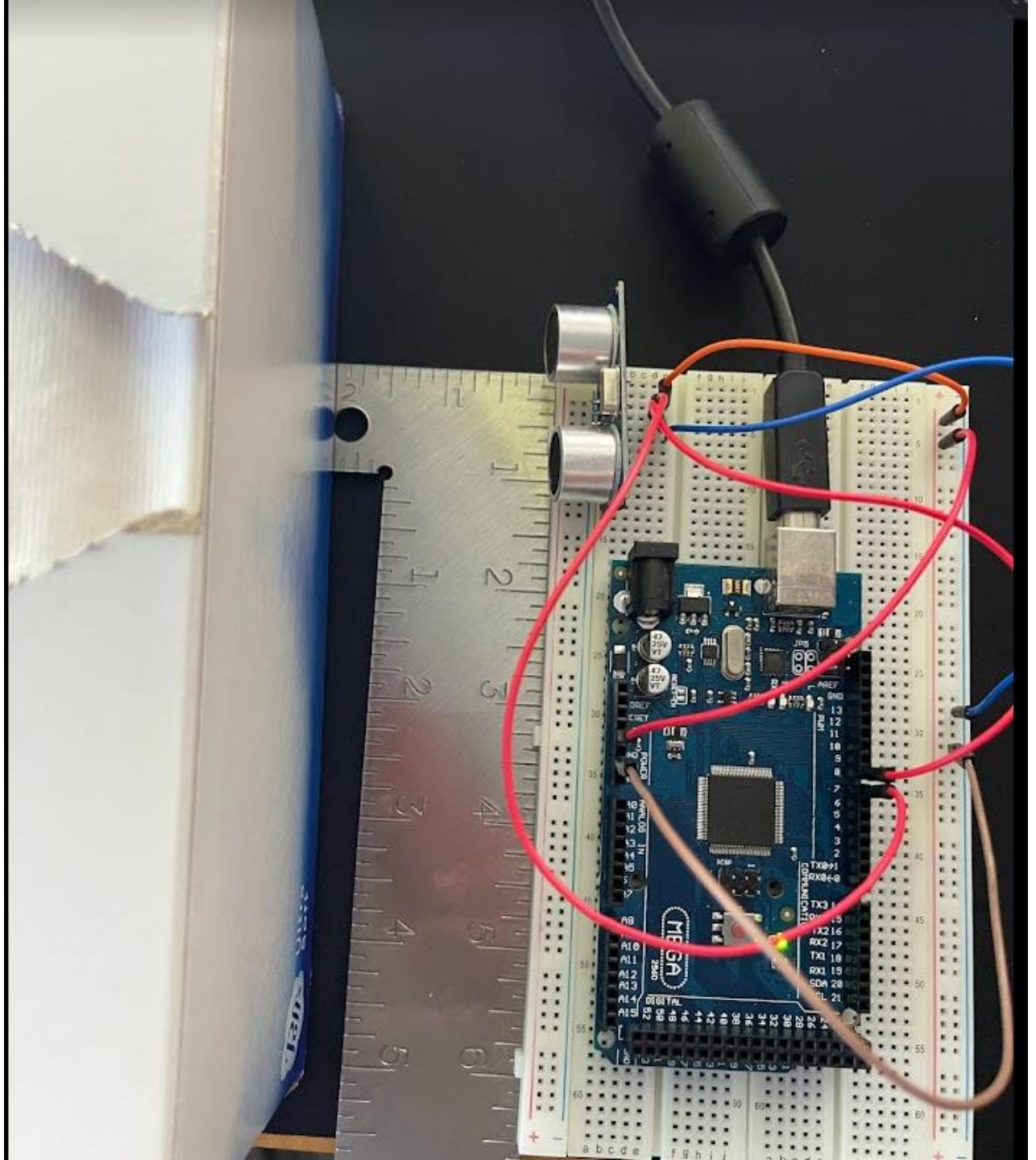
PHYS204
Module 3

Gravitational Acceleration

Experimental Set-up (Picture)

Materials List:

- Mega 2560 Board
- Ultrasonic sensor HC-SR04
- Male to Male Wires
- Breadboard
- Object to undergo free fall motion



Serial Monitor (Screenshot)

Include screenshot of raw data showing the start of the fall and end of the fall of one trial.

Must include your name displayed in the serial monitor.

```
PHYS204 Module 4 Project
Name: Glenn Delostrico
Speed of sound: 343.00 m/s
Initial distance to ground: 69.29 c
TIME[s] Distance[cm]    Ready! 321
counter:28
0.0014   7.94
0.0103   8.20
0.0192   9.57
0.0281   10.29
0.0372   11.78
0.0463   12.50
0.0554   13.67
0.0646   14.97
0.0740   16.89
0.0834   18.38
0.0929   19.59
0.1025   21.75
0.1122   23.62
0.1220   25.42
0.1320   27.15
0.1420   29.29
0.1522   31.49
0.1625   33.94
0.1729   36.46
0.1835   39.10
0.1943   41.79
0.2052   44.85
0.2163   48.40
0.2276   51.21
0.2391   54.93
0.2508   58.60
0.2628   63.28
```

Excel Table (Screenshot)

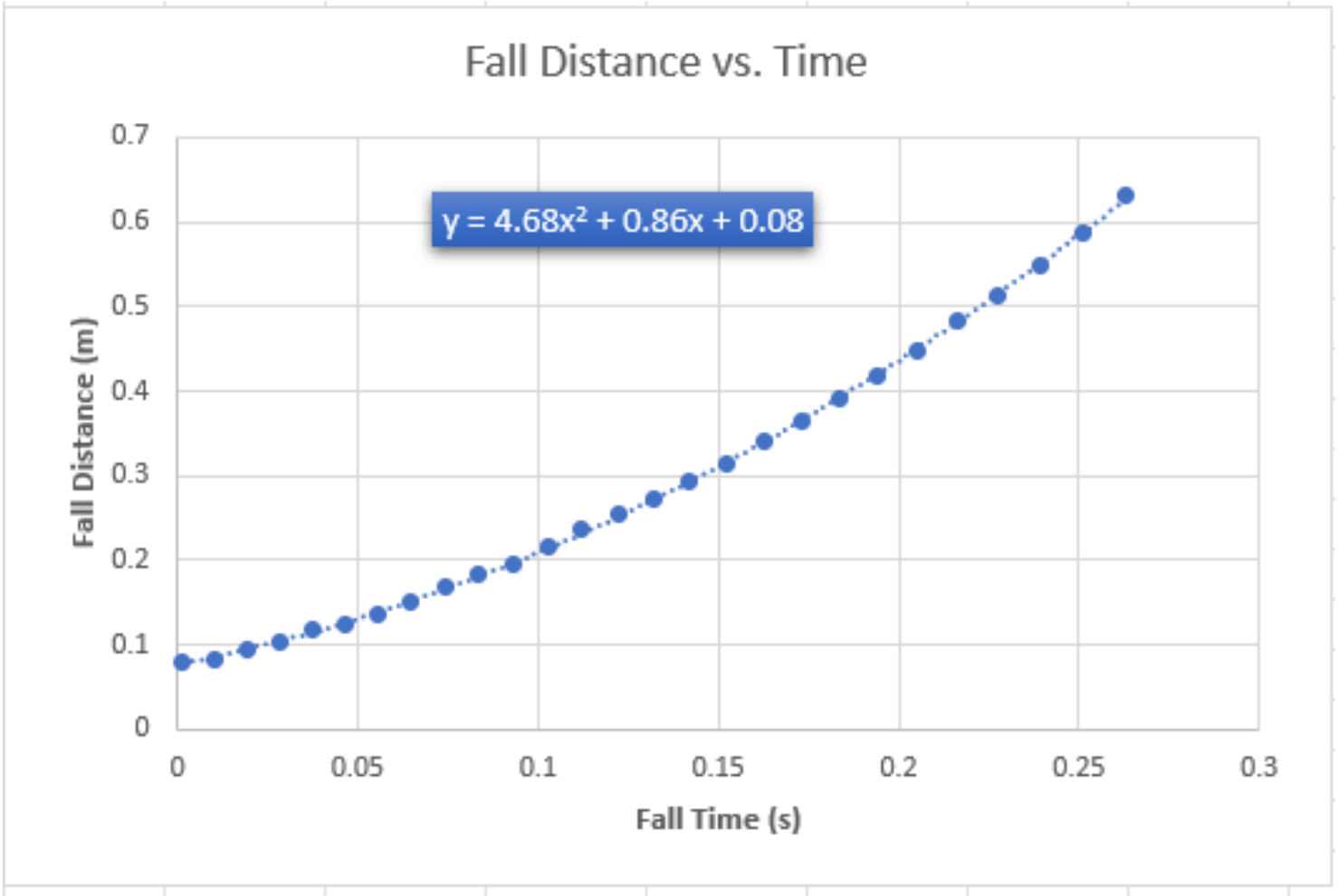
Include all values in the Excel table for a single trial showing the fall distance in centimeters and meters as a function of time

Time (s)	Distance (cm	Distance (m)
0.0014	7.94	0.0794
0.0103	8.2	0.082
0.0192	9.57	0.0957
0.0281	10.29	0.1029
0.0372	11.78	0.1178
0.0463	12.5	0.125
0.0554	13.67	0.1367
0.0646	14.97	0.1497
0.074	16.89	0.1689
0.0834	18.38	0.1838
0.0929	19.59	0.1959
0.1025	21.75	0.2175
0.1122	23.62	0.2362
0.122	25.42	0.2542
0.132	27.15	0.2715
0.142	29.29	0.2929
0.1522	31.49	0.3149
0.1625	33.94	0.3394
0.1729	36.46	0.3646
0.1835	39.1	0.391
0.1943	41.79	0.4179
0.2052	44.85	0.4485
0.2163	48.4	0.484
0.2276	51.21	0.5121
0.2391	54.93	0.5493
0.2508	58.6	0.586
0.2628	63.28	0.6328

Excel Graph (Screenshot)

Include Excel graph for a single trial showing the fall distance as a function of time.

Must include equation for curve fitting.



Data Collection

Trial	x^2 coefficient value from curve fitting	Acceleration (m/s^2) = 2* (x^2 coefficient)
1	4.68	9.36 m/s
2	5.02	10.04 m/s
3	4.66	9.32 m/s
4	4.62	9.24 m/s
5	4.73	9.46 m/s

Data Analysis

- Average acceleration from table

$$a_{avg} = \frac{a_1+a_2+a_3+a_4+a_5}{5} = 9.484 \text{ m/s}$$

- Percent difference with $g = 9.8\ m/s^2$

$$Percent\ difference\ = \frac{|a_{avg} - g|}{g} \times 100\% = 3.22\%$$

Note: Use meters and seconds for all calculations. Show the appropriate units for measured and calculated values

PHYS204
Module 4

Conservation of Energy

Excel Table (Screenshot)

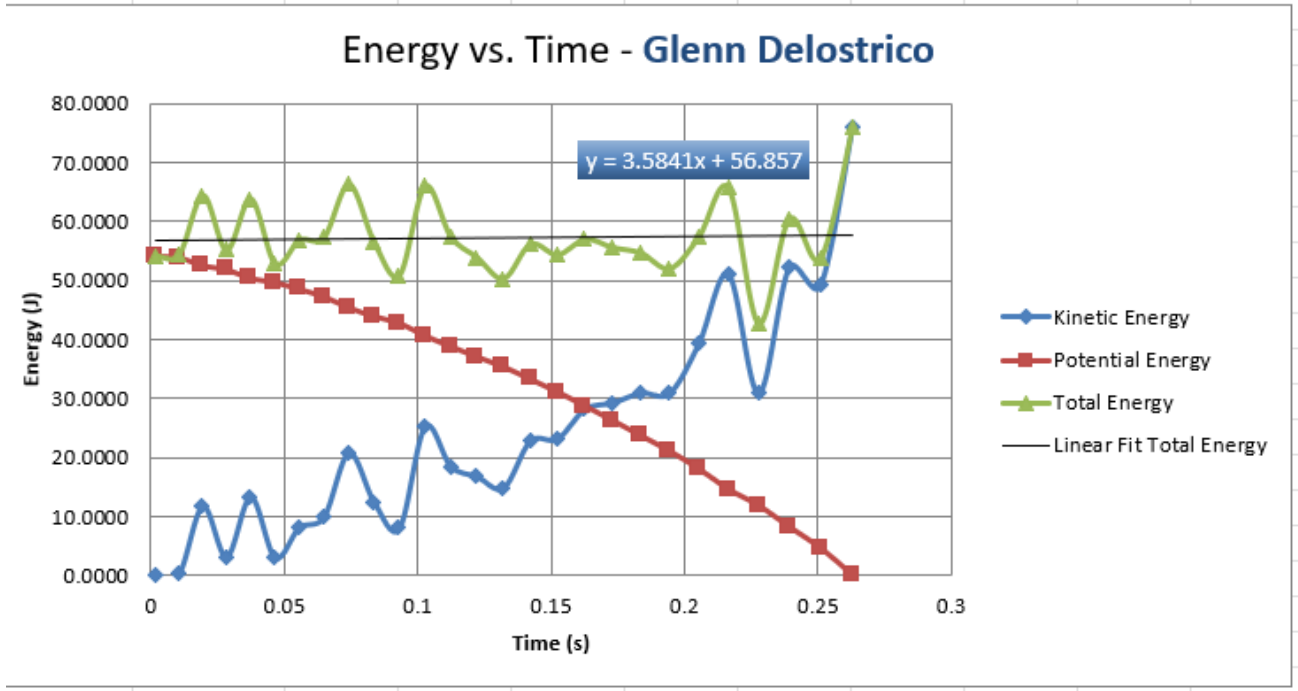
Include all values in the Excel table for a single trial showing the fall distance in centimeters and meters as a function of time with the values generated for kinetic energy K, potential energy U, and total mechanical energy E.

t (s)	*y* (cm)	y (m)	h (m)	*v* (m/s)	*K* (J)	*U* (J)	*E* (J)
0.0014	7.94	0.0794	0.55	0.00	0.0000	54.2332	54.2332
0.0103	8.2	0.0820	0.55	0.29	0.4267	53.9784	54.4051
0.0192	9.57	0.0957	0.54	1.54	11.8476	52.6358	64.4834
0.0281	10.29	0.1029	0.53	0.81	3.2723	51.9302	55.2025
0.0372	11.78	0.1178	0.52	1.64	13.4048	50.4700	63.8748
0.0463	12.5	0.1250	0.51	0.79	3.1301	49.7644	52.8945
0.0554	13.67	0.1367	0.50	1.29	8.2653	48.6178	56.8831
0.0646	14.97	0.1497	0.48	1.41	9.9835	47.3438	57.3273
0.074	16.89	0.1689	0.46	2.04	20.8601	45.4622	66.3223
0.0834	18.38	0.1838	0.45	1.59	12.5628	44.0020	56.5648
0.0929	19.59	0.1959	0.44	1.27	8.1114	42.8162	50.9276
0.1025	21.75	0.2175	0.42	2.25	25.3125	40.6994	66.0119
0.1122	23.62	0.2362	0.40	1.93	18.5827	38.8668	57.4495
0.122	25.42	0.2542	0.38	1.84	16.8680	37.1028	53.9708
0.132	27.15	0.2715	0.36	1.73	14.9645	35.4074	50.3719
0.142	29.29	0.2929	0.34	2.14	22.8980	33.3102	56.2082
0.1522	31.49	0.3149	0.32	2.16	23.2603	31.1542	54.4145
0.1625	33.94	0.3394	0.29	2.38	28.2897	28.7532	57.0429
0.1729	36.46	0.3646	0.27	2.42	29.3565	26.2836	55.6401
0.1835	39.1	0.3910	0.24	2.49	31.0146	23.6964	54.7110
0.1943	41.79	0.4179	0.21	2.49	31.0189	21.0602	52.0791
0.2052	44.85	0.4485	0.18	2.81	39.4058	18.0614	57.4672
0.2163	48.4	0.4840	0.15	3.20	51.1424	14.5824	65.7248
0.2276	51.21	0.5121	0.12	2.49	30.9190	11.8286	42.7476
0.2391	54.93	0.5493	0.08	3.23	52.3191	8.1830	60.5021
0.2508	58.6	0.5860	0.05	3.14	49.1961	4.5864	53.7825
0.2628	63.28	0.6328	0.00	3.90	76.0500	0.0000	76.0500

Excel Graph (Screenshot)

Include Excel graph for a single trial showing the plots of the kinetic energy K, potential energy U, and total mechanical energy E as a function of time.

Must include your name in the title of the graph.



Data Validation

- Final velocity from experimental data (largest velocity)

  $v_{experimental}$ = 3.9 m/s

- Theoretical value of final velocity.

  $h = y_{final} - y_{initial}$ = .6328 - .0794 = .5534m

  $v_f = \sqrt{2gh}$ =3.17 m/s

- Percent difference

$$Percent\ difference\ = \frac{\left|v_f - v_{experimental}\right|}{v_f} \times 100\% = 18.72\%$$

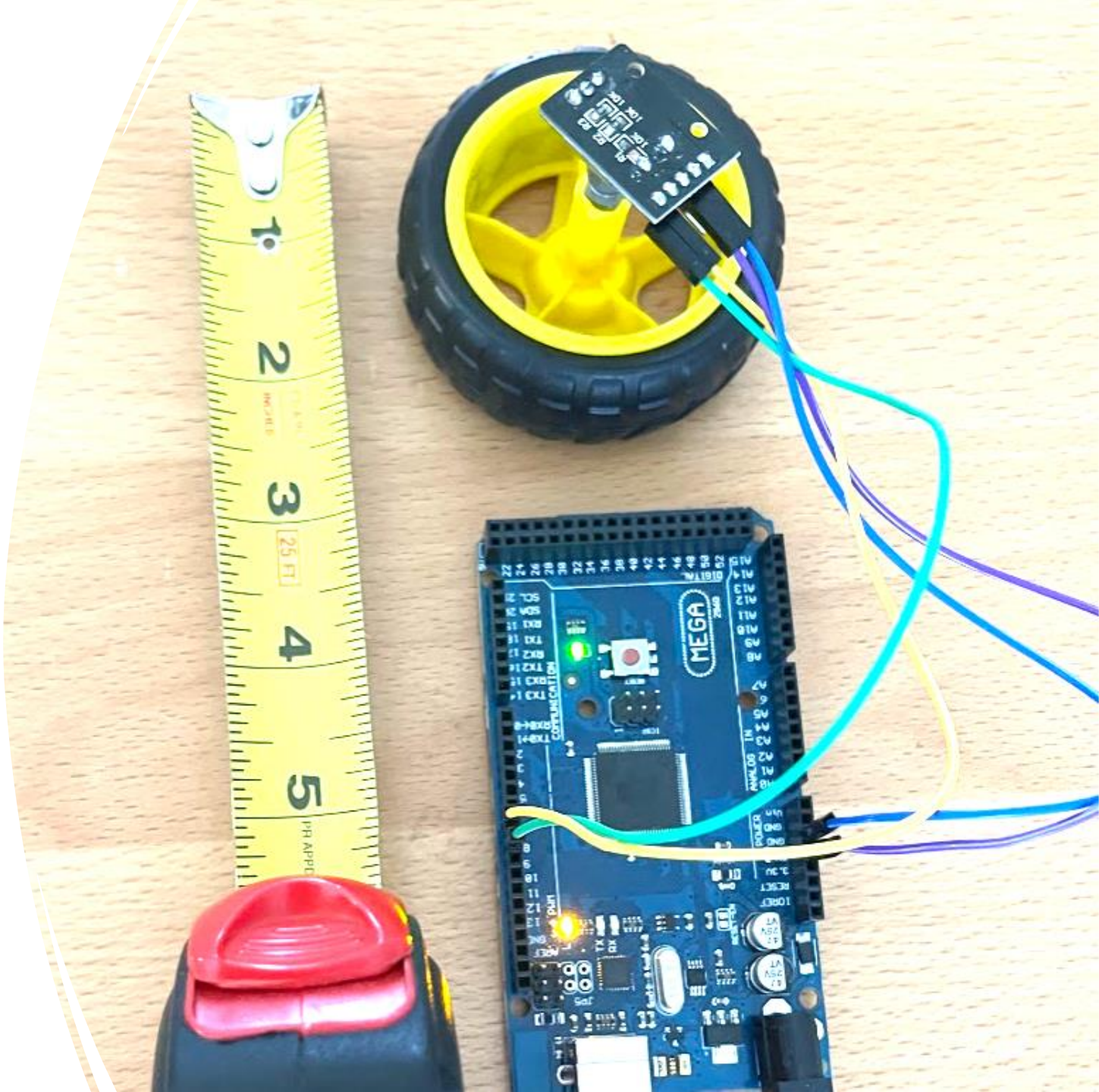
Note: Use meters and seconds for all calculations. Show the appropriate units for measured and calculated values

PHYS204
Module 5

Rotational Motion

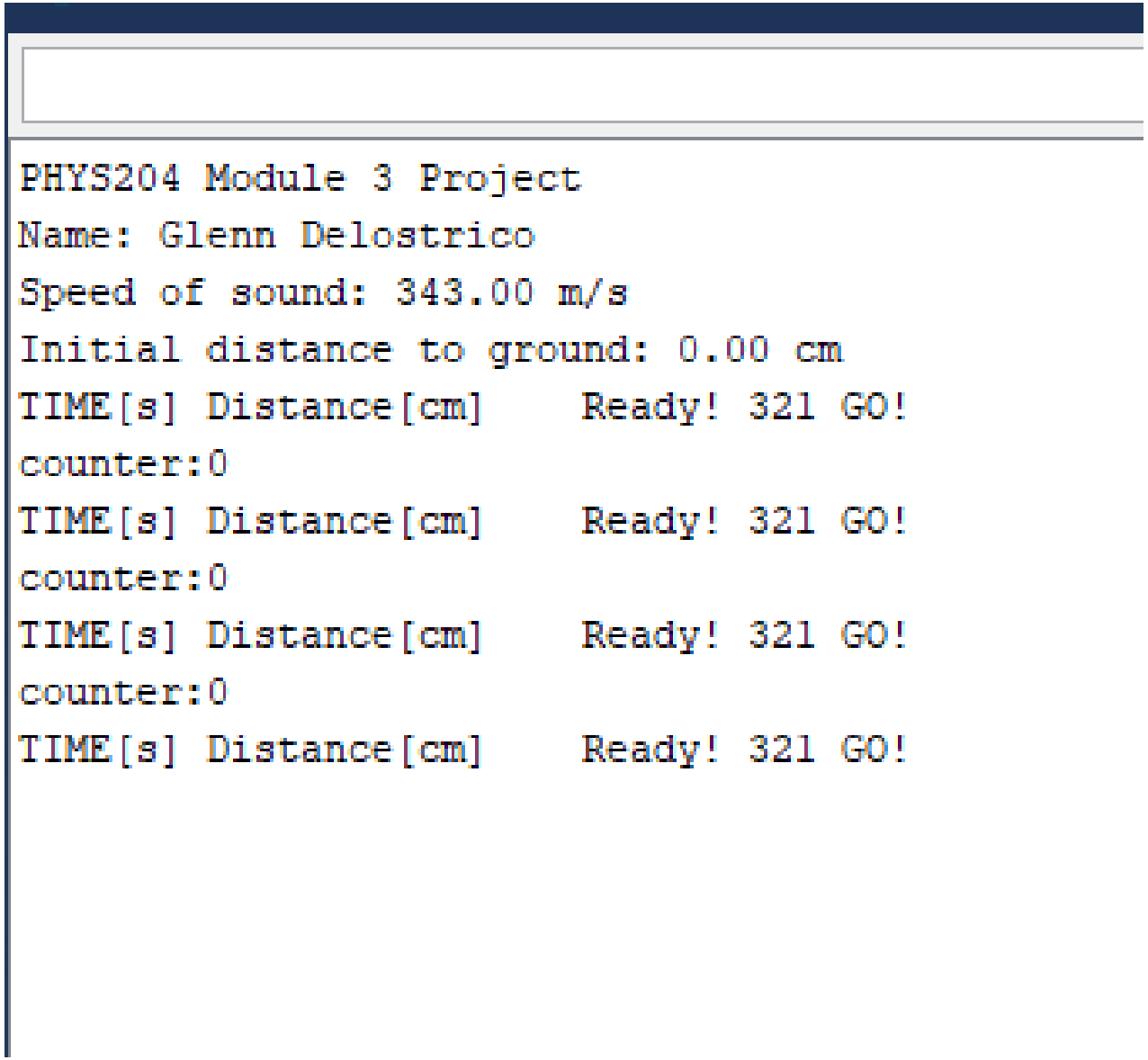
Experimental Set-up (Picture)

- Materials List:
- Mega 2560 Board
- Rotary Encoder Module KY-040
- Male to Female Wires
- Object to attach onto rotary encoder
  (e.g. cork, bottle cap, ball)
- Ruler or tape measurer



Raw Data (Screenshot)

- Screenshot of Serial Monitor from Arduino IDE showing raw data.
- **Must include your name displayed in the serial monitor.**



Data Collection

- Object diameter: d = 2.5in
- Object radius: r = 1.25in
- Number of pulses for one revolution: x = 31
- Resolution = $\left(\frac{1}{x}\ \frac{Revolution}{pulses}\right) \cdot \left(\frac{2 \cdot \pi\ radians}{1\ Revolution}\right) = 0.203$ radian/pulses

Data Analysis

Trial	Number of pulses N	Encoder distance $r \cdot Resolution \cdot N$	Measured distance with ruler	Percent difference %
1	23	5.84cm	6cm	2.67%
2	27	6.85cm	7cm	2.14%
3	31	7.87cm	8cm	1.65%
4	35	8.88cm	9cm	1.33%
5	39	9.9cm	10cm	1%

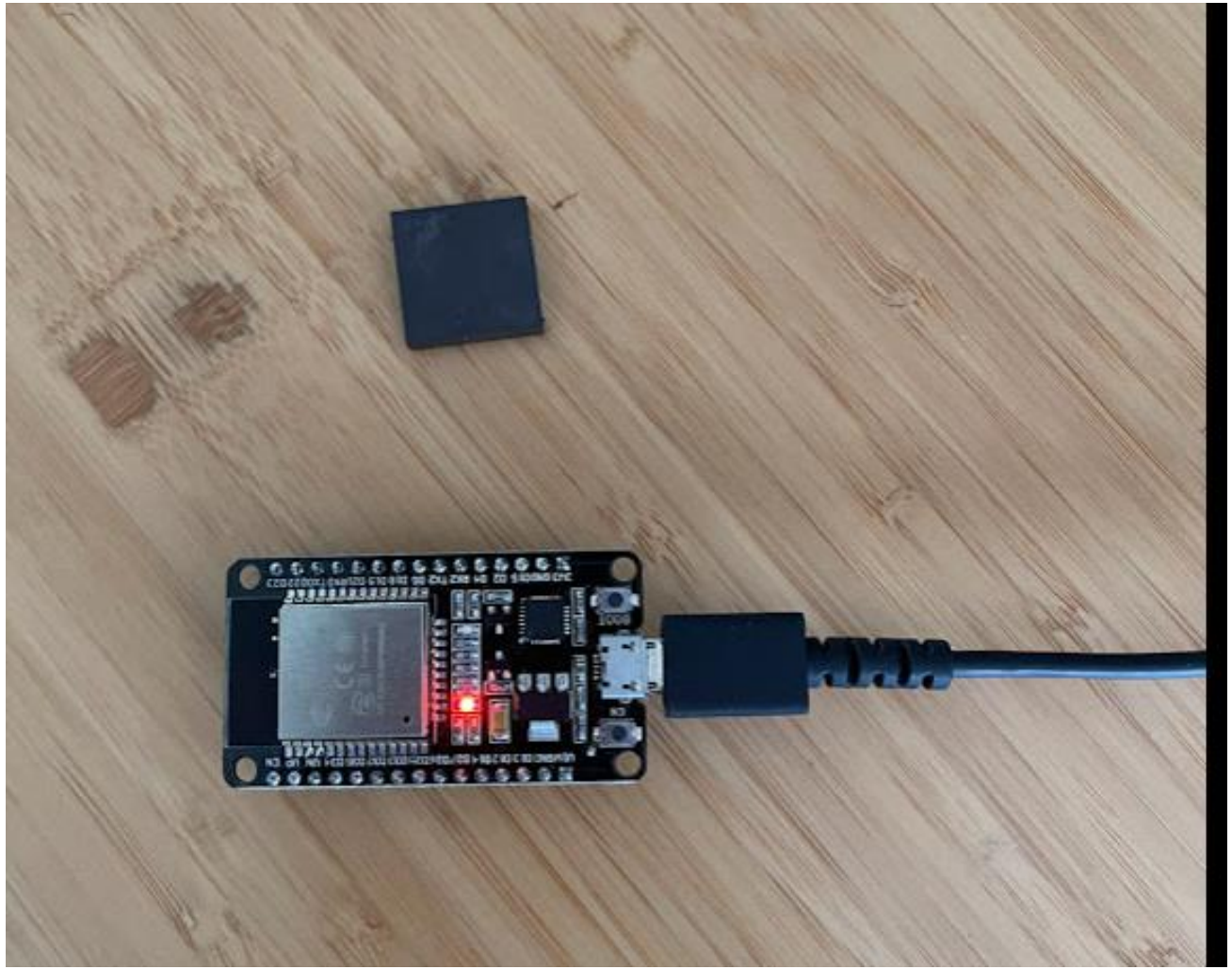
PHYS204
Module 6

Hall Effect

Experimental Set-up (Picture)

Materials List:

- ESP32 microprocessor
- Micro-USB cable
- Magnet

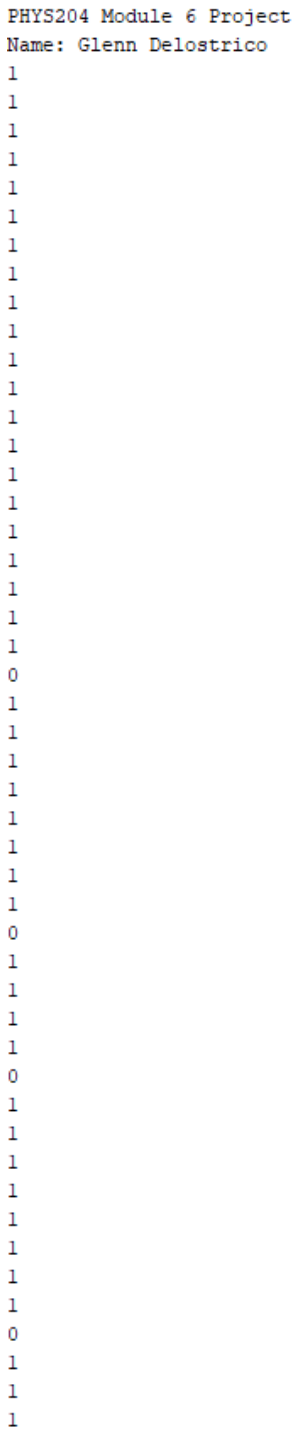


Raw Data (Screenshot)

Screenshot of Serial Monitor from Arduino IDE showing raw data.

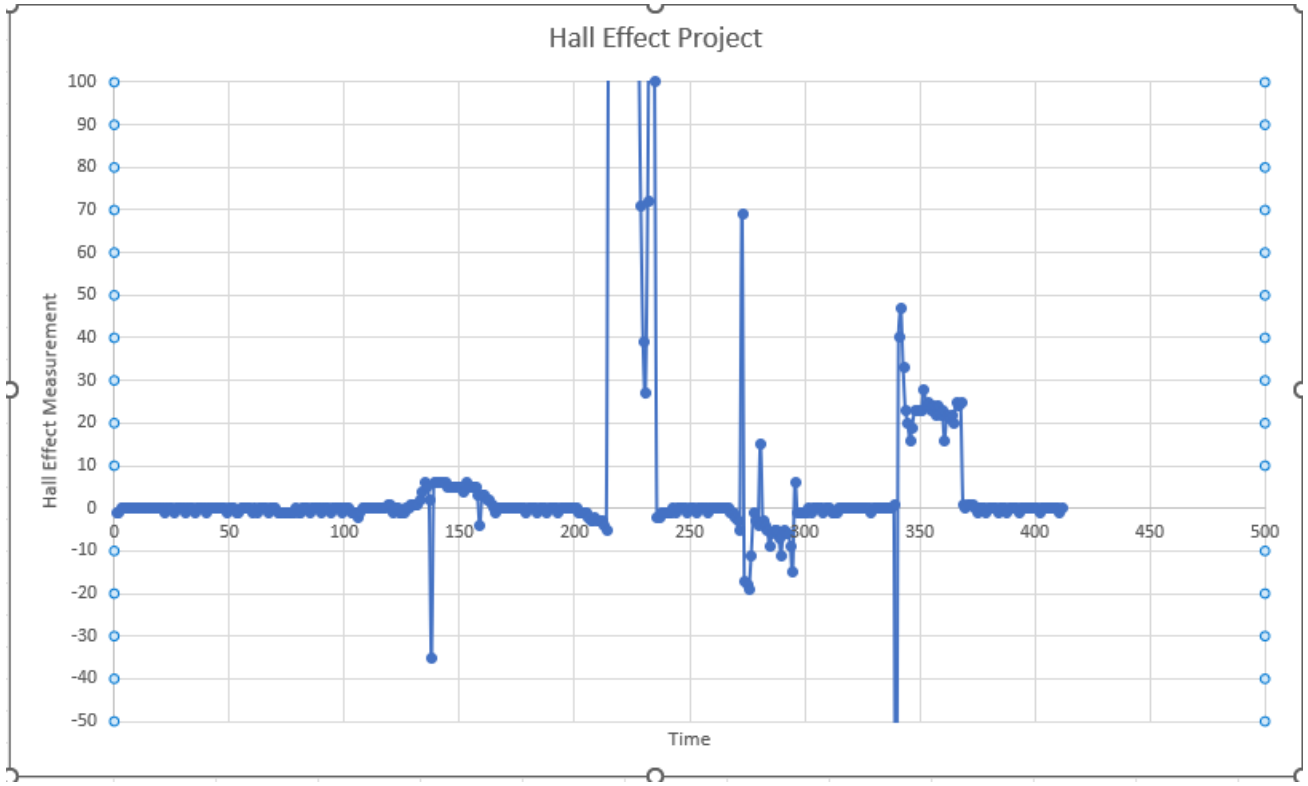
Must include your name displayed in the Serial Monitor.

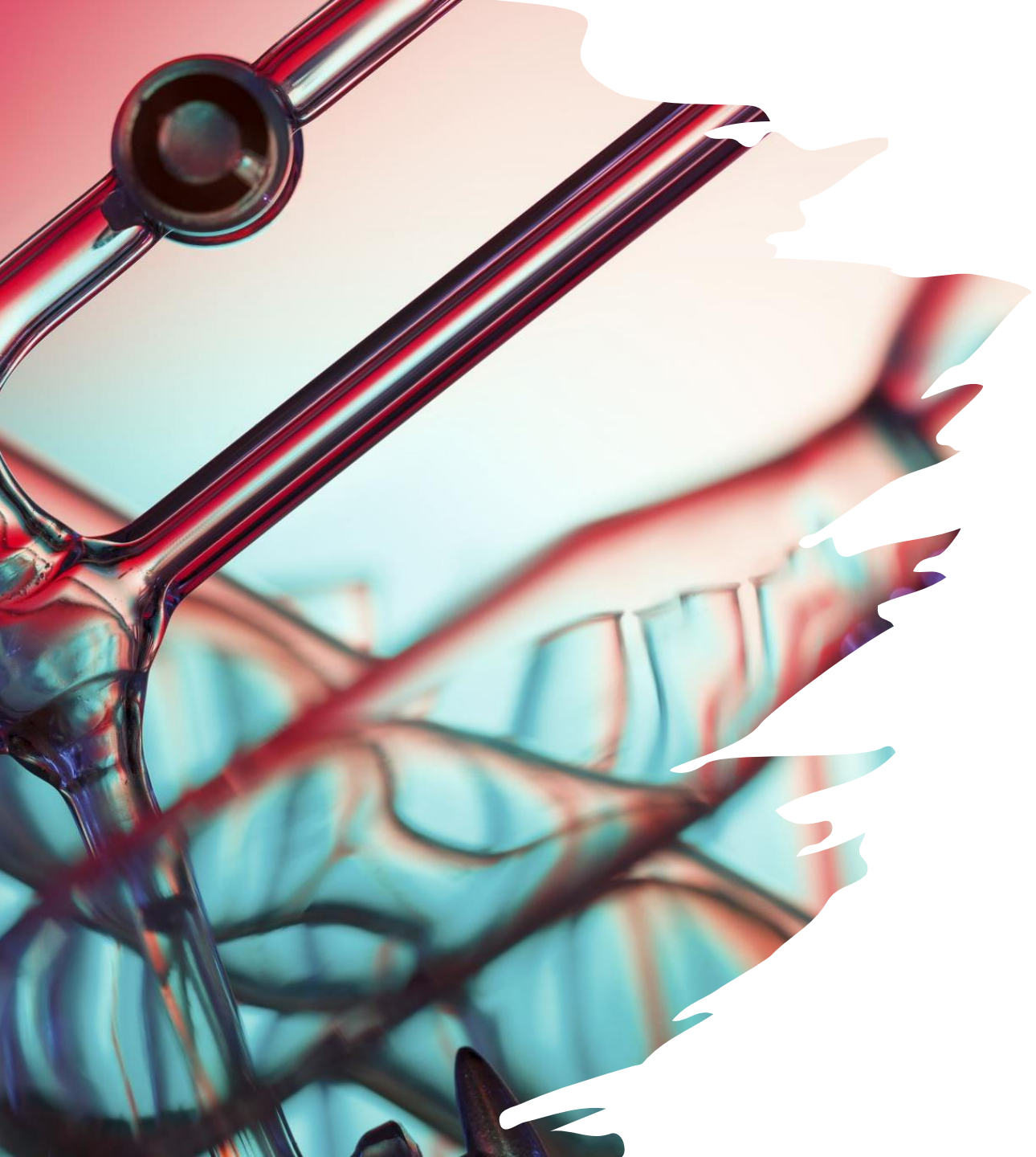
Unselect “Autoscroll” and scroll all the way up.



Data Analysis (Screenshot)

Screenshot data plotted in Excel.





Challenges

- What challenges did you face and overcome?
  - One of the challenges I faced was timing in the gravitational acceleration experiment. Overcoming this situation was to keep trying again until I received a desired results.
- What parts of the project created the most difficulty?
  - This was also the most difficult project due to repeating the experiments repeatedly.

Career Skills

- What skills were developed that will benefit your career?
  - Problem Solving
  - Data Collection
  - Data Analysis
  - Arduino Programming
- What competencies will help you gain the opportunities to advance your career?
  - This experiments helped me to understand the importance of data collection, problem solving and analyzing data. Patience is a virtue that I also learned. Experiments aren’t necessary going to work the first time around.