Applied Physics

TECH204

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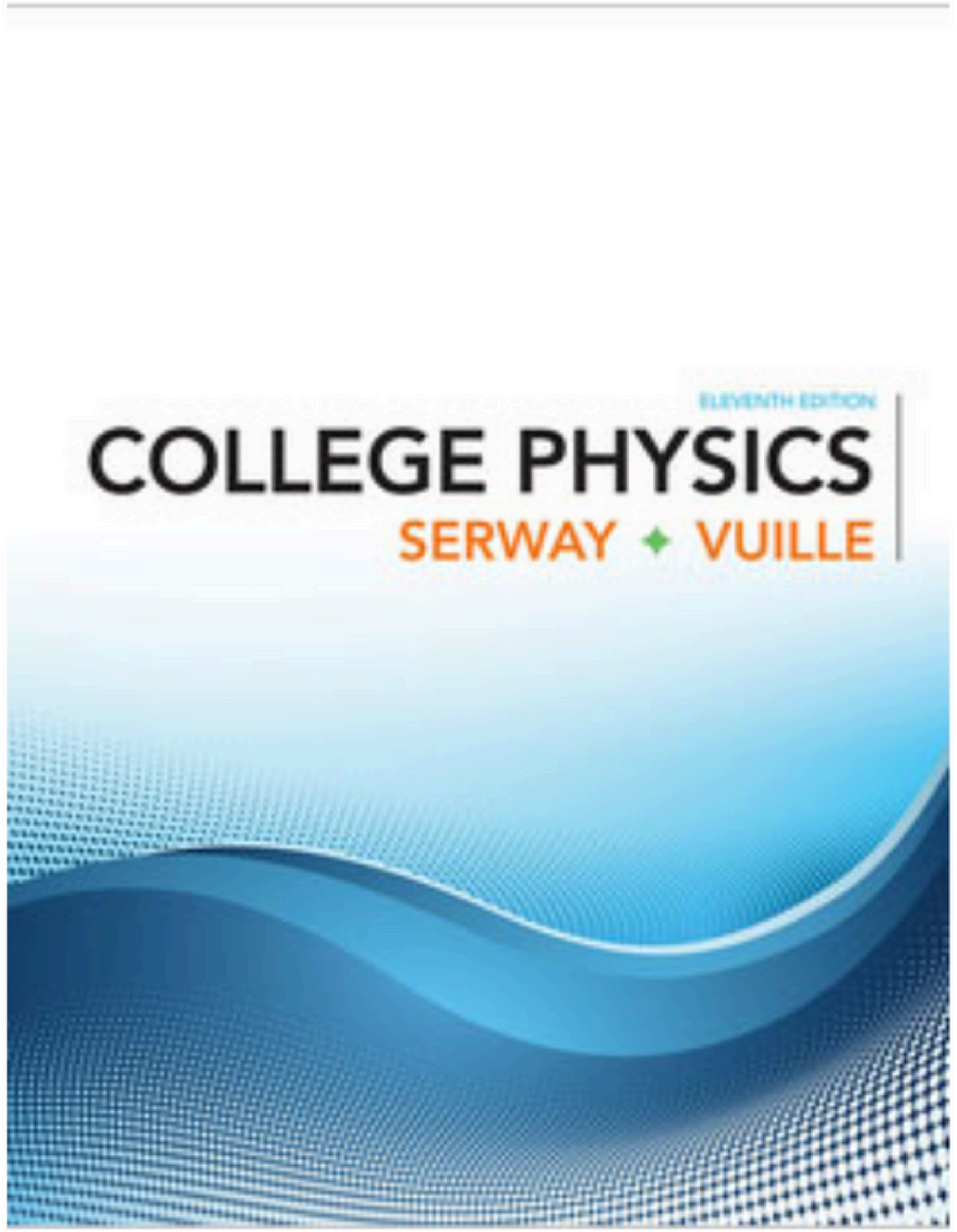
Introduction

Applied Physics TECH204 course is about understanding physics through **real experiment data instead of hands-on tests**. We explored how objects move, how energy changes, and how sensors measure things like distance and magnetism.

We used **Excel to organize data, create graphs, and compare results to real physics laws.** This helped us see how physics connects to technology in things like cars, robots, and everyday devices.

The **goal** of this project was to apply physics to real life, understand how small factors can affect measurements, and learn how sensors help track motion and forces.

Material Used

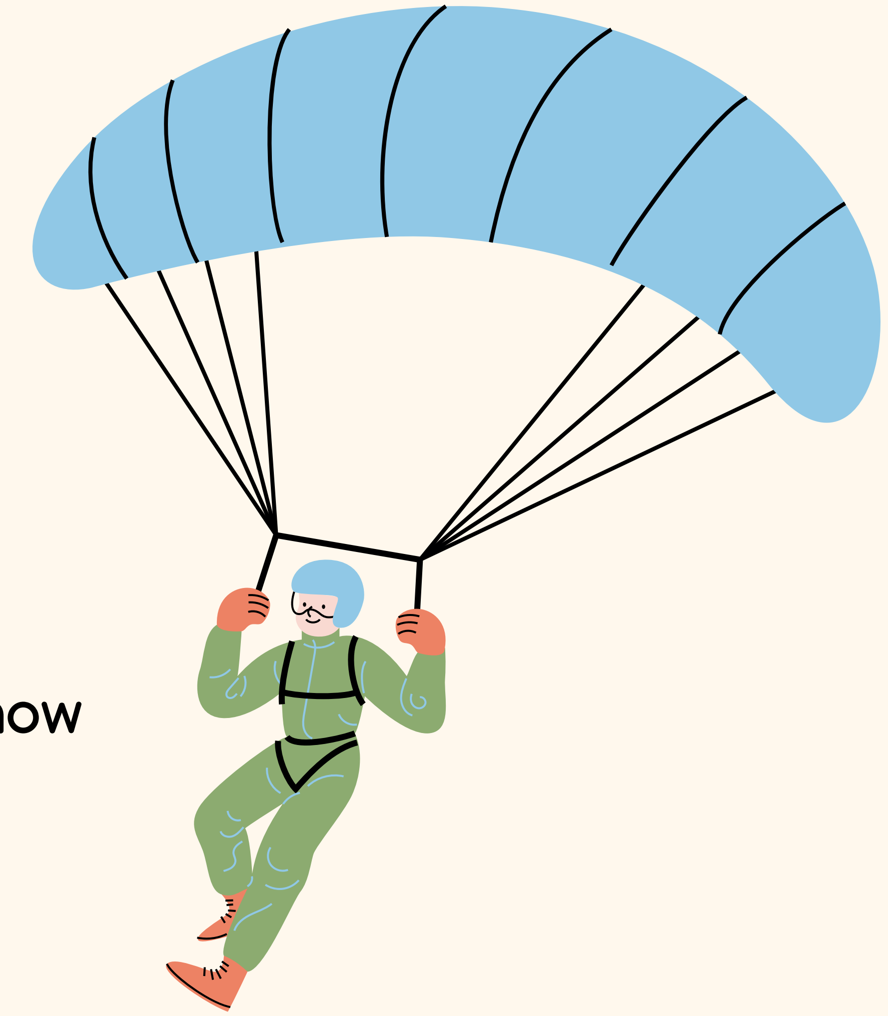


desmos Scientific Calculator

EXCEL

Project Part 1

Inventory of Parts and Software



In this project, we are looking at **experiment data to understand how sensors work and how physics applies to technology.** Instead of using the actual sensors, we are studying the information given to us to see how they collect and process data.

To do this, we used **Microsoft Excel to organize and analyze the data.** We also used course materials to learn about the sensors and took screenshots to keep track of our work.

The **goal** of this part is to understand what the **sensors measure, analyze the data using physics,** and use **Excel** to make sense of the results. By studying this data, we can see how physics connects to real-world technology without having to run the experiments ourselves.

Ultrasonic Sensor HC-SR04

• Describe the working principles of ultrasonic sensors in detail.

Answer:

The HC-SR04 ultrasonic sensor works by using sound to measure how far away something is.

It has two main parts: one sends out sound waves, and the other listens for the sound that bounces back.

- First, the sensor sends out a quick sound wave. When the wave hits something like an object, it bounces back, and the sensor catches it.
- The time it takes for the sound to go out and come back is used to figure out the distance, with the help of a simple formula.
- Since the sound makes a round trip (out and back), the time is divided by two to get the correct distance.

$$\text{Distance} = \frac{\text{Time} \times \text{Speed of Sound}}{2}$$

To start working, the sensor needs a small signal (like a quick pulse) and a 5V power supply.

When running, it gives an output signal that tells how long the sound wave took to return.

This signal can be used to measure distance or detect objects, making it useful in things like robots or even checking the level of a liquid in a tank.

The sensor can measure distances from 2 cm to 400 cm, with about 3 mm of accuracy.

It doesn't work well in every condition, such as things like temperature, humidity, or soft surfaces (which don't reflect sound well) can affect the accuracy.

To make it more accurate, the sensor can be calibrated by testing it with known distances.

Rotary Encoder KY-040

• Describe the working principles of ultrasonic sensors in detail.

Answer:
The Rotary Encoder KY-040 is like a volume knob on a radio or an old-school gaming joystick.
When you turn it, it sends signals that tell how far you turned it and in which direction.
Inside, it has a wheel with patterns and two tiny detectors that read these patterns as you turn the knob.
By reading the patterns, it knows if you're turning left or right and how much you're turning.

The only input it really needs is for you to turn the knob. It also needs a power supply, usually around 5V, to work.

The sensor gives an output that shows how many steps you've turned and in which direction.
Each step is a small movement that can be counted by a program or a device.

The output can be used to measure rotation.
EX: you can use it to...

- Adjust the volume on a device
    - ***New Volume=Current Volume+(Steps Turned×Volume Step Size)***
- Control the speed of something, like a motor
    - ***New Speed=Current Speed+(Steps Turned×Speed Step Size)***
- Change values in a program, like increasing or decreasing numbers
    - ***New Value=Current Value+(Steps Turned×Step Size)***

The Rotary Encoder KY-040 has some limits.

- It can detect 20 or 30 steps in one full turn, which is called its resolution.
- It works well for simple tasks, but if you turn it too fast, it might miss some steps.
- Also, it doesn't know where it starts, so you have to set a starting point yourself.

You don't need to calibrate it like some other sensors. You just have to make sure your program knows how to handle the number of steps and the direction correctly.

Hall Effect Sensor in ESP32

• Describe the working principles of the Hall Effect Sensor in detail.

Answer:

The Hall effect sensor in the ESP32 can sense magnetic fields. It's built inside the **ESP32** microcontroller, under the metal cover.
When you bring a magnet near the **ESP32,** the sensor notices the magnetic field and gives a reading. The stronger or closer the magnet is, the higher the voltage the sensor produces. If you turn the magnet around, the voltage can even go negative because the sensor can tell which side of the magnet is facing it.

When a magnet comes close, the sensor reacts by creating a voltage.
•The stronger the magnet, or the closer it is, the more voltage the sensor makes.
• When you move the magnet away, the voltage goes down.

The sensor needs power from the **ESP32** to work, and it needs a magnet nearby to detect the magnetic field.
•The output is a voltage that changes depending on the strength of the magnetic field.
•A strong magnet gives a high voltage, and a weak magnet gives a low voltage. If you flip the magnet, the voltage can become negative.
•The voltage tells you how strong the magnetic field is. In a experiment, you'll see how changes in the magnetic field affect the voltage.

The formula for the Hall effect sensor in the **ESP32** can be thought of as
• ***Magnetic field strength=Constant×Voltage***

The sensor works best when the magnet is close or strong enough.
•The sensor might not give a clear reading, if the magnet is too weak or too far
•If the magnet is very strong, the sensor might hit its maximum reading and won't detect anything stronger than that.

You can calibrate it by testing the sensor with a magnet you already know the strength of, then adjusting the readings to match correctly.

Screenshots

- What tool will you used to take screenshots? How does it work?

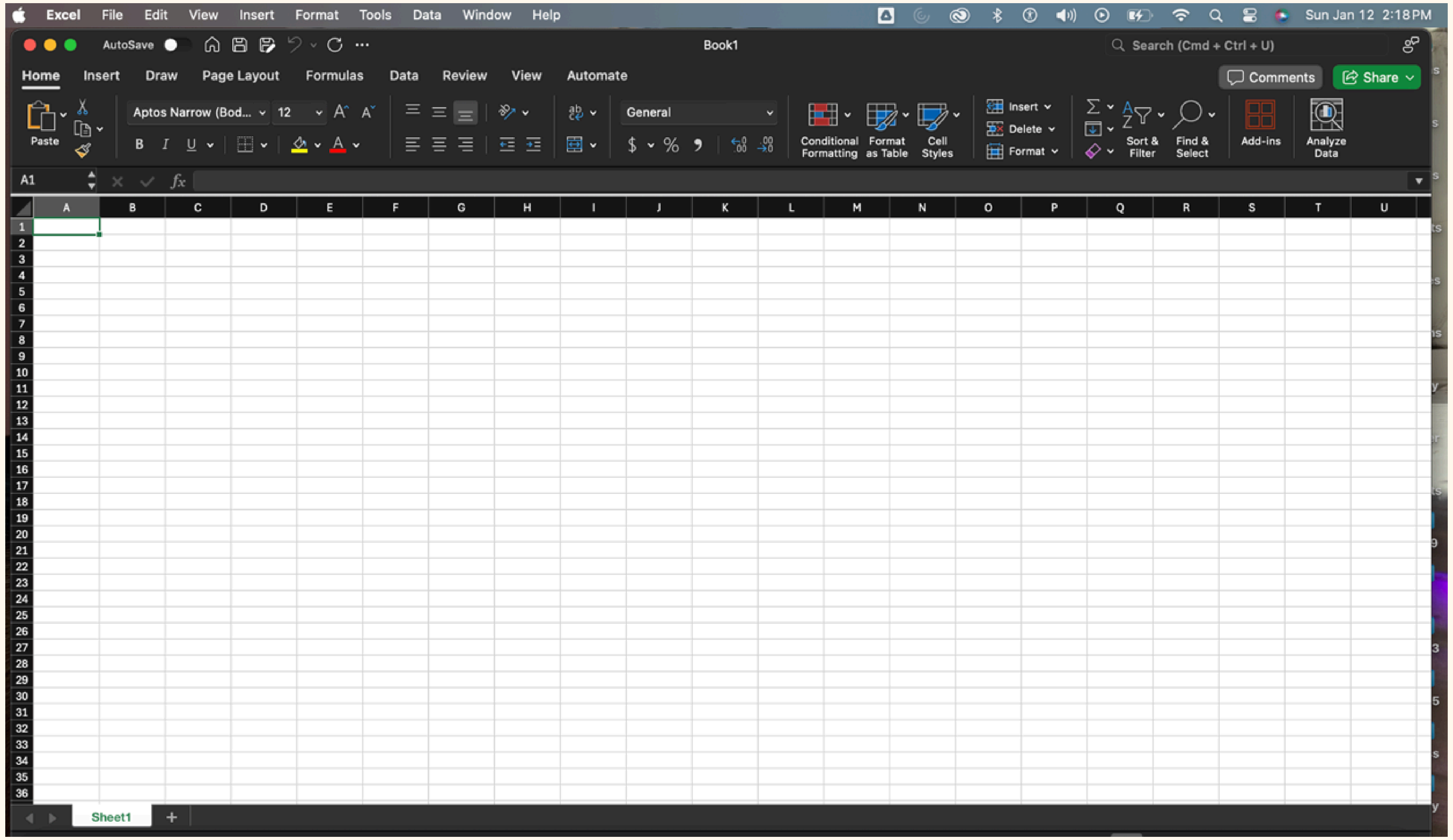
I took a screenshot on my MacBook Pro

- **Open screenshot options:**

  Press **Command + Shift + 5**. You'll see options to take pictures or record your screen.

Required Software

Screenshot of Microsoft Excel installed and running on your computer



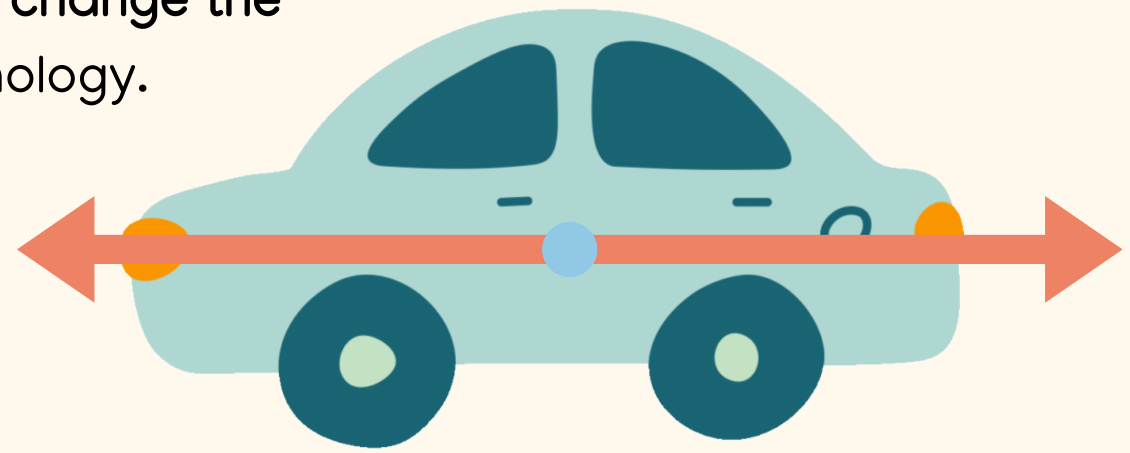
Project Part 2

Precision of the Ultrasonic Sensor

In this part of the project, we analyzed data to understand how **precise the ultrasonic sensor is when measuring distance.** Instead of using the sensor ourselves, we studied the given experiment results and used physics calculations to see how accurate the measurements were.

To do this, we looked at the **collected data, calculated the average velocity of sound, and compared it to the known speed of sound.** We also found the **percent difference** to see how close the results were to the expected value.

The **goal** of this part was to see how well the sensor works, **understand small errors that might affect accuracy, and learn how factors like temperature, humidity, and pressure can change the speed of sound.** This helped us connect physics concepts to real-world sensor technology.



Data Collection

Trial	Ruler Distance (cm)	Total Roundtrip Distance (m)	Time from Serial Monitor (microseconds)	Roundtrip time (s)	Velocity = distance/ time (m/s)
1	8	16/100=0.16	492	492 x 10^ -6 = 0.000492	325.2
2	10	20/100=0.2	586	586 x 10^-6= 0.000586	341.3
3	15	30/100=0.3	925	925 x 10^-6= 0.000925	324.3
4	20	40/100=0.4	1187	1187 x 10^-6= 0.001187	337.0
5	30	60/100=0.6	1724	1724 x 10^-6= 0.001724	347.8

Data Analysis

- Average velocity from table

$$v_{avg} = \frac{v_1 + v_2 + v_3 + v_4 + v_5}{5}$$

Answer: **335.12 m/s** ______ *units*

$$\frac{325.2+341.3+324.3+337.0+347.8}{5}$$

$$\frac{1675.6}{5} = 335.12 m/s$$

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

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

Answer: **2.30%** ______ *units*

$$\frac{|\ 335.12-343\ |}{343} \times 100$$

Percent Difference=2.30%

Conclusions

- Briefly describe and explain the results.
  - Answer:

I believe the experiment went well because the results were very close to the expected speed of sound.

- The average speed we got was **335.12** m/s, which is only about **2.3%** different from the actual value of **343 m/s**.
- Since the difference is less than **5%**, it shows the experiment was accurate.
- The small difference could be caused by little errors,
  - like timing mistakes
  - room temperature changes
  - how the equipment was set up

- What is the dependence of temperature, humidity, and atmospheric pressure on the speed of sound? How does it affect the results?
  - Answer:

Temperature: The warmer it is, the faster sound moves because heat makes air molecules move quicker. For example, sound travels slower on cold days.

Humidity: When there is more water in the air (like on humid days), sound moves faster because water vapor is lighter than dry air.

Atmospheric Pressure: At normal conditions, pressure does not change sound speed much, but big altitude changes (like going to a mountain) can make a small difference.

- My Last Thoughts…

The experiment was good because the percent difference was small, showing that the results were accurate.
Small errors are normal in experiments, so this one turned out well.
The setup and method worked, and the data matched the theoretical speed of sound closely.

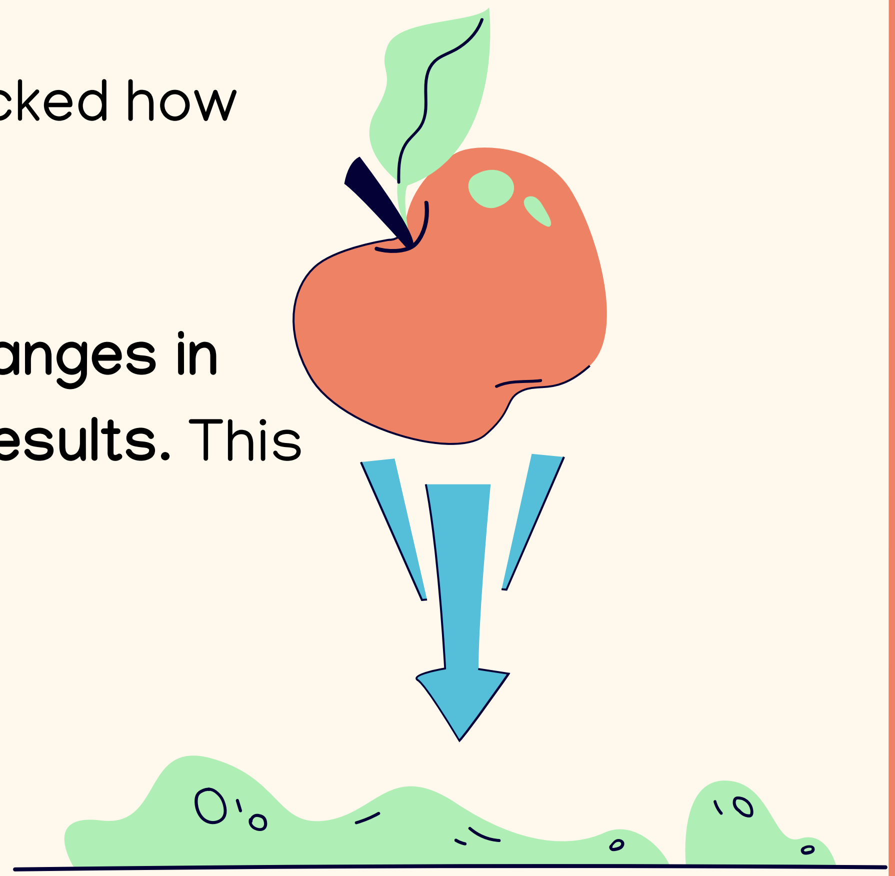
Project Part 3

Gravitational Acceleratio of a Free-Fallling Object

In this part of the project, we studied how **objects fall due to gravity by analyzing experiment data.** Instead of dropping objects ourselves, we looked at the given measurements and used physics formulas to calculate acceleration.

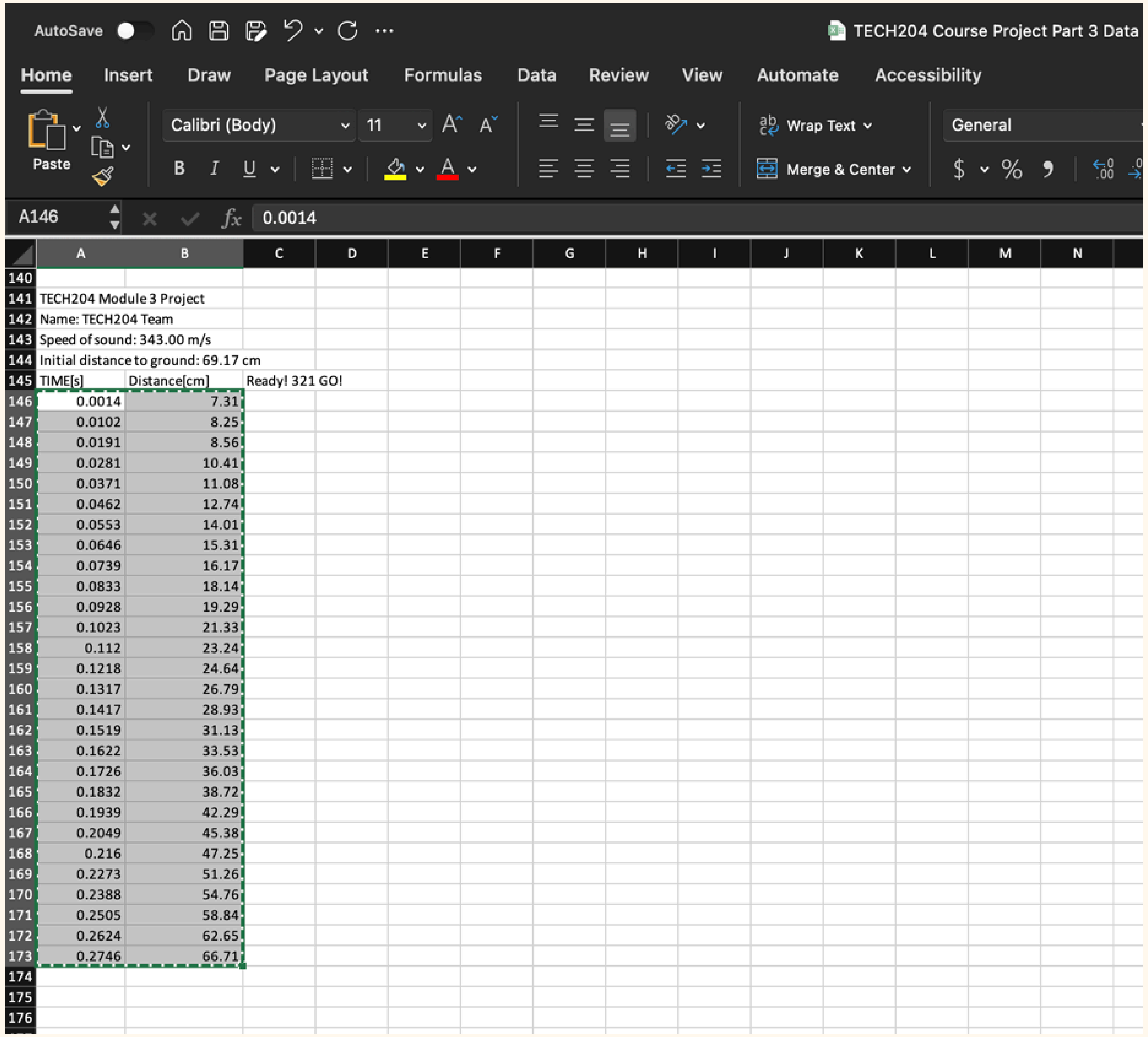
The data showed how far the object fell over time, which we graphed in **Excel to find the acceleration.** By comparing our results to the known value of **gravity (9.8 m/s^2)**, we checked how accurate the experiment was.

The **goal** of this part was to understand how **gravity affects falling objects, analyze changes in acceleration, and see how small errors like air resistance or timing delays can affect results.** This helped us apply physics concepts to real-world motion.



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



TECH204 Course Project Part 3 Data

TECH204 Module 3 Project
Name: TECH204 Team
Speed of sound: 343.00 m/s
Initial distance to ground: 69.17 cm

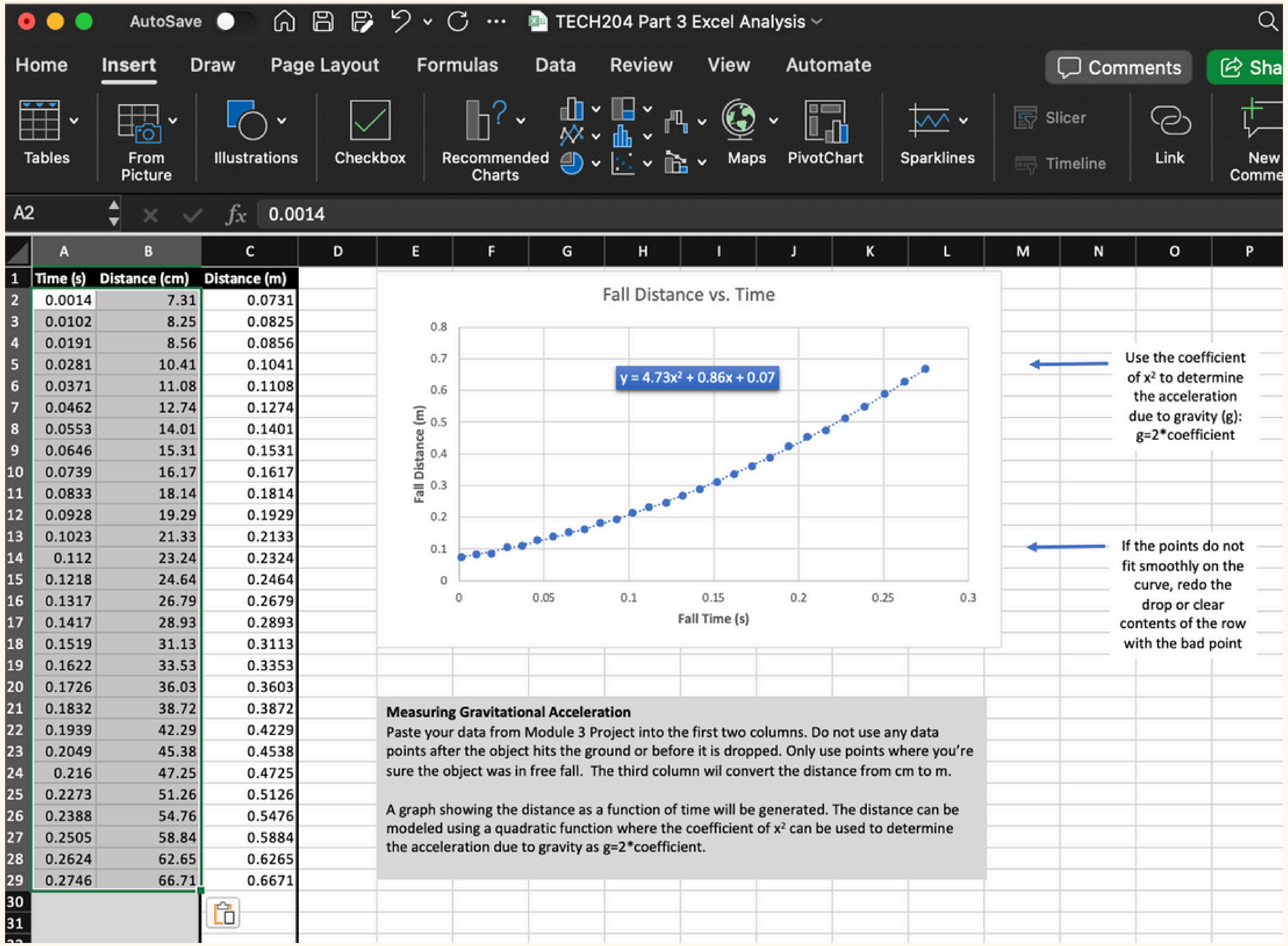
TIME[s]	Distance[cm]	Ready! 321 GO!
0.0014	7.31	
0.0102	8.25	
0.0191	8.56	
0.0281	10.41	
0.0371	11.08	
0.0462	12.74	
0.0553	14.01	
0.0646	15.31	
0.0739	16.17	
0.0833	18.14	
0.0928	19.29	
0.1023	21.33	
0.112	23.24	
0.1218	24.64	
0.1317	26.79	
0.1417	28.93	
0.1519	31.13	
0.1622	33.53	
0.1726	36.03	
0.1832	38.72	
0.1939	42.29	
0.2049	45.38	
0.216	47.25	
0.2273	51.26	
0.2388	54.76	
0.2505	58.84	
0.2624	62.65	
0.2746	66.71	

Excel Graph (Screenshot)

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

Confirm that most data points fall along the curve fitting.

The x^2 coefficient should be between 2.5 and 7.5 such that its yields an acceleration value between 5 m/s^2 and 15 m/s^2



Time (s)	Distance (cm)	Distance (m)
0.0014	7.31	0.0731
0.0102	8.25	0.0825
0.0191	8.56	0.0856
0.0281	10.41	0.1041
0.0371	11.08	0.1108
0.0462	12.74	0.1274
0.0553	14.01	0.1401
0.0646	15.31	0.1531
0.0739	16.17	0.1617
0.0833	18.14	0.1814
0.0928	19.29	0.1929
0.1023	21.33	0.2133
0.112	23.24	0.2324
0.1218	24.64	0.2464
0.1317	26.79	0.2679
0.1417	28.93	0.2893
0.1519	31.13	0.3113
0.1622	33.53	0.3353
0.1726	36.03	0.3603
0.1832	38.72	0.3872
0.1939	42.29	0.4229
0.2049	45.38	0.4538
0.216	47.25	0.4725
0.2273	51.26	0.5126
0.2388	54.76	0.5476
0.2505	58.84	0.5884
0.2624	62.65	0.6265
0.2746	66.71	0.6671

Data Collection

Trial	x^2 coefficient value from curve fitting	Acceleration (m/s^2) = 2* (x^2 coefficient)
1	4.68	9.38 m/s^2
2	5.02	10.04 m/s^2
3	4.66	9.32 m/s^2
4	4.62	9.24 m/s^2
5	4.73	9.46 m/s^2

Data Analysis

- Average acceleration from table

$$a_{avg} = \frac{a_1 + a_2 + a_3 + a_4 + a_5}{5}$$

Answer: 9.484 m/s^2 ______ ______ *units*

9.36+10.04+9.32+9.24+9.46
____
5

47.42
_____ = 9.484 m/s^2
5

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

$$Percent\ difference = \frac{\left|a_{avg} - g\right|}{g} \times 100$$

Answer: 3.22% ______ ______ *units*

| 9.484 - 9.8 |
____________ x 100
9.8

Conclusions

- ***Briefly describe and explain the results.***
    - ***Answer:***

This weeks experiment we measured gravity by dropping an object and tracking how fast it fell.
Our results for acceleration were between **9.24 m/s^2 and 10.04 m/s^2**, with an average of **9.484 m/s^2**.
The real value of gravity on Earth is **9.8 m/s^2**, so we were pretty close.
We also calculated the **percent difference**, which came out to **3.22%**. This means our experiment was fairly accurate, but not perfect.

A few things might have caused small errors:

- Tiny delays in starting or stopping measurements.
- Air slowing the object down just a little.
- Small mistakes in recording the data.

Now if we used a **lighter** object or one with a different shape, air resistance could have affected it more, making our results less reliable.

- ***How much variation is there from trial to trial? What does this indicate about the uncertainty of the result?***
    - ***Answer:***

Each time we dropped the object, the acceleration **wasn't exactly** the same. The numbers moved around a bit.

To see **how much they changed**, we found the **range**, which is just:

Highest value — lowest value
10.04ms/^2 - 9.24m/s^2 = 0.8 m/s^2

So, the difference between our fastest and slowest measured acceleration was **0.8 m/s^2**.

- **Why does variation matter?**
  If our numbers jump around too much, it means the results aren't as reliable. If they stay close together, we can trust them more.
- **What is uncertainty?**
  Uncertainty is how sure we are about our results. If every trial gives a different number, there's a lot of **uncertainty**. If all numbers are close, we can be more confident.
- **Is high or low uncertainty better?**
  Low uncertainty is better because it means our results are steady and trustworthy. High uncertainty means something is off—maybe errors in measurement or other outside effects like air resistance.
- **How can we improve?**
    - Make sure we drop the object the same way every time.
    - Use better tools for measuring, like high-speed cameras.
    - Do more trials and take an average to even out small mistakes.

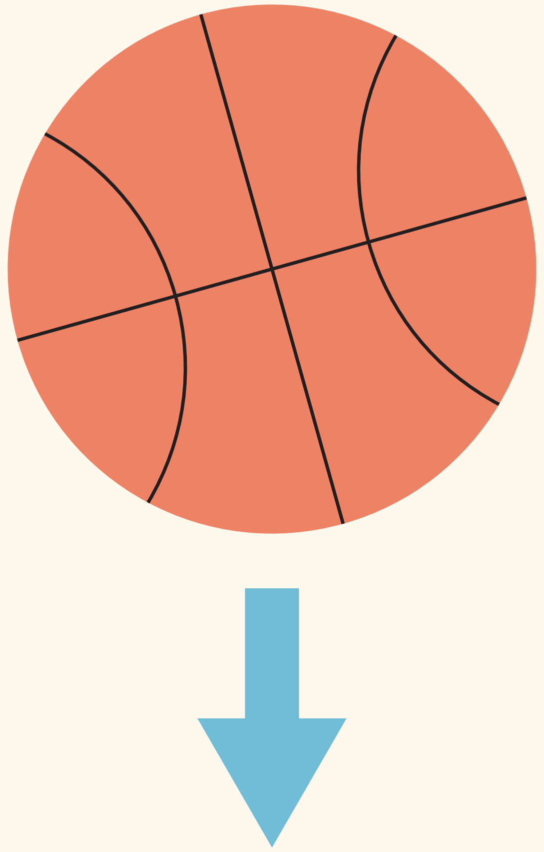
Project Part 4

Conservation of Energy of a Free-Falling Object

In this part of the project, we explored how energy changes when an object falls. Instead of dropping an object ourselves, **we analyzed data to see how potential energy (stored energy) turns into kinetic energy (motion energy) as the object moves.**

We used an **Excel table to track distance, speed, and energy over time.** By creating a graph, we could see that total energy stays nearly the same, proving that energy is not lost but just changes form.

The **goal** of this part was to understand how energy works in free-fall, check if total energy stays constant, and see how small factors like air resistance can cause tiny energy losses. This helped connect physics concepts to real-world motion.



Excel Table (Screenshot)

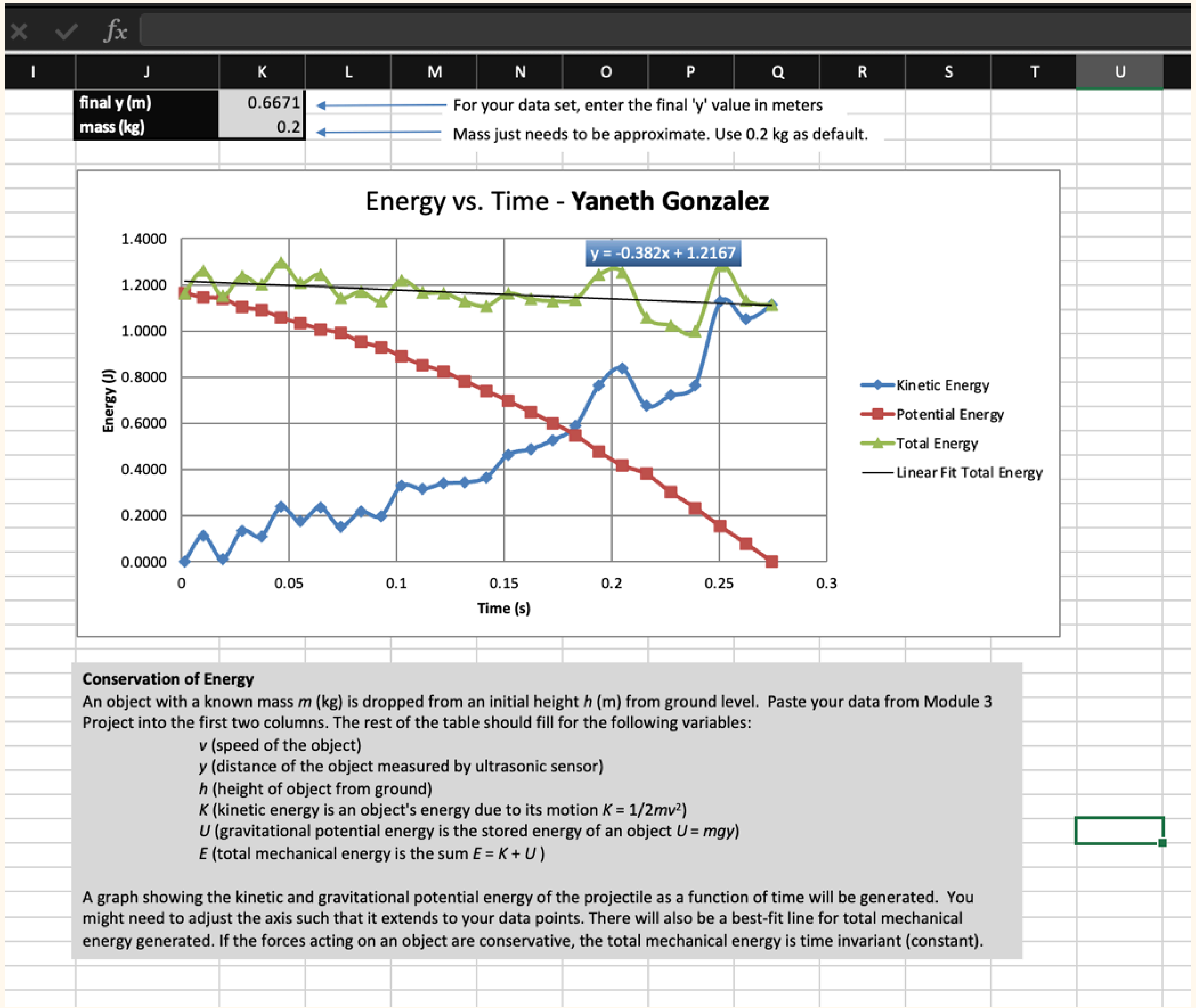
Include all values in the Excel table for a single trial showing the fall distance in centimeters and meters as a function of time with the values generated for kinetic energy K, potential energy U, and total mechanical energy E.

	A	B	C	D	E	F	G	H
1	*t* (s)	*y* (cm)	y (m)	h (m)	*v* (m/s)	*K* (J)	*U* (J)	*E* (J)
2	0.0014	7.31	0.0731	0.59	0.00	0.0000	1.1642	1.1642
3	0.0102	8.25	0.0825	0.58	1.07	0.1141	1.1458	1.2599
4	0.0191	8.56	0.0856	0.58	0.35	0.0121	1.1397	1.1519
5	0.0281	10.41	0.1041	0.56	1.16	0.1348	1.1035	1.2383
6	0.0371	11.08	0.1108	0.56	1.05	0.1107	1.0903	1.2010
7	0.0462	12.74	0.1274	0.54	1.54	0.2379	1.0578	1.2957
8	0.0553	14.01	0.1401	0.53	1.32	0.1752	1.0329	1.2081
9	0.0646	15.31	0.1531	0.51	1.54	0.2366	1.0074	1.2440
10	0.0739	16.17	0.1617	0.51	1.24	0.1533	0.9906	1.1439
11	0.0833	18.14	0.1814	0.49	1.48	0.2176	0.9520	1.1695
12	0.0928	19.29	0.1929	0.47	1.41	0.1992	0.9294	1.1286
13	0.1023	21.33	0.2133	0.45	1.82	0.3301	0.8894	1.2196
14	0.112	23.24	0.2324	0.43	1.78	0.3158	0.8520	1.1678
15	0.1218	24.64	0.2464	0.42	1.84	0.3403	0.8246	1.1649
16	0.1317	26.79	0.2679	0.40	1.86	0.3449	0.7824	1.1273
17	0.1417	28.93	0.2893	0.38	1.92	0.3670	0.7405	1.1075
18	0.1519	31.13	0.3113	0.36	2.16	0.4649	0.6974	1.1623
19	0.1622	33.53	0.3353	0.33	2.21	0.4883	0.6503	1.1387
20	0.1726	36.03	0.3603	0.31	2.30	0.5280	0.6013	1.1293
21	0.1832	38.72	0.3872	0.28	2.42	0.5880	0.5486	1.1366
22	0.1939	42.29	0.4229	0.24	2.76	0.7636	0.4786	1.2423
23	0.2049	45.38	0.4538	0.21	2.89	0.8380	0.4181	1.2560
24	0.216	47.25	0.4725	0.19	2.60	0.6763	0.3814	1.0577
25	0.2273	51.26	0.5126	0.15	2.69	0.7213	0.3028	1.0241
26	0.2388	54.76	0.5476	0.12	2.77	0.7656	0.2342	0.9998
27	0.2505	58.84	0.5884	0.08	3.36	1.1286	0.1543	1.2828
28	0.2624	62.65	0.6265	0.04	3.25	1.0530	0.0796	1.1326
29	0.2746	66.71	0.6671	0.00	3.34	1.1142	0.0000	1.1142
30								
31								
32								
33								
34								

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 Analysis

- Theoretical value of final velocity

$h = y_{final} - y_{initial} =$ 0.594m (units)

$v_f = \sqrt{2gh} =$ 3.41m/s (units)

h= 0.6671 - 0.0731
h= 0.594m

vf= ↓2 x 9.8 x 0.594
vf= ***3.41m/s***

- Final velocity from experimental data (or largest velocity)

$v_{experimental} =$ 3.34m/s (units)

Looking at **Column E("v(m/s)" in my excel table**
The highest recorded velocity is
3.34m/s

- Percent difference

$$Percent\ difference = \frac{|v_f - v_{experimental}|}{v_f} \times 100$$

Answer: 2.05% (units)

$$\frac{|3.41 - 3.34|}{3.41} \times 100$$

= 2.05%

Conclusions

- Discuss the key characteristics of the plot. Consider the points when potential energy U is maximum, U is minimum, kinetic energy K is maximum, K is minimum and when U and K are the same value. What is the significance of these points?
  - Answer:

When U is maximum, K is minimum:

- This happens at the very start, when the object is at its **highest point**.
- The object isn't moving yet, so all its **energy is potential energy (U) and kinetic energy (K) is zero.**

When U is minimum, K is maximum:

- This happens right before the **object hits the ground**.
- All the **potential energy has turned into kinetic energ**y, meaning the object is moving at its **fastest speed**.

When U and K are the same value:

- This happens at the **halfway point of the fall**.
- The object has fallen halfway down, so half of its energy is still potential energy, and the other **half has turned into kinetic energy**.

What is the significance of these points?

- They show how **energy transforms** but never disappears.
- **Potential energy turns into kinetic energy** as the object falls.
- This follows the Law of Conservation of Energy, proving that energy isn't lost, it just changes form.

This experiment shows **energy in action**, just like jumping off a diving board. You start with **stored energy (U), then gain speed (K) as you fall**.
The total energy stays mostly the same, just shifting between types.

Conclusions

- What is the trend of the best fit line for the total energy E in your data? If the data is accurate, the total mechanical energy should decrease slightly. Why is that?
    - Answer:

What's happening in the graph?

- The best-fit line for **total energy should be flat** if no energy is lost.
- But in real life, the **line slopes down slightly,** meaning the total energy **decreases a little over time**.

Why does total energy drop slightly?

Even though energy is supposed to be conserved, small things **cause tiny losses**, like:

- **Air resistance** (air pushes against the object, slowing it down a little).
- **Sensor errors** (the readings aren't 100% perfect).
- **Tiny amounts of energy turning into heat** (as the object moves through air).

Does this ruin the experiment?

No. This is totally expected in a real experiment.

- The fact that the **line stays mostly steady** (but drops slightly) means the **experiment is accurate**.
- **If the line dropped a lot**, it would mean **something went wrong** (like major energy loss).

The small decrease in total energy is just real-life physics at work. If everything were perfect, the line would be flat, but the small drop just shows that tiny outside forces steal a little energy.

Project Part 5

Relationship between Linear and Rotational Motion

In this part of the project, we studied how **linear motion (straight-line movement) and rotational motion (spinning movement) are connected.** Instead of measuring this directly, we analyzed experiment data to see how a rotating object's motion translates into distance traveled.

We used data from a **rotary encoder, which tracks rotation using pulses.** By calculating how far the object moved in each trial, we compared the encoder's results to actual measurements with a ruler. This helped us see how accurate the rotary encoder is in tracking movement.

The **goal** of this part was to understand how rotation turns into **straight-line motion, check how close the encoder's measurements were to real distances, and learn where small errors might come from.** This connects physics concepts to real-world technology like wheels, motors, and tracking systems.

Data Collection

- Object diameter: d = 7 *cm* ________ ________ *units*
- Object radius: r = 3.5 *cm* ________ ________ *units*
- Number of pulses for one revolution: x = 40 *pulses* ________
- Resolution = $\left(\frac{1}{x}\ \frac{Revolution}{pulses}\right) \bullet \left(\frac{2 \bullet \pi\ radians}{1\ Revolution}\right) =$ 0.1571 *rad/pulses* ________ ________ *units*

Data Analysis

Trial	Number of pulses *N*	Encoder distance *r N*	Measured distance with ruler	Percent difference
1	14	7.69 cm	8	3.88%
2	17	9.34 cm	10	6.60%
3	21	11.53 cm	12	3.92%
4	27	14.83 cm	14	5.93%
5	30	16.48 cm	16	3.00%

Conclusions

- *Briefly describe and explain the results.*

  Answer:

The **rotary encoder and the ruler** gave pretty close results.
The difference between them was small, around ***3% to 6%***, which means the encoder did a good job at measuring distance.

Would I trust the encoder over a ruler?
Mostly, yes. The numbers were really close, so it's accurate. But, like anything, it's **not perfect**.

What could have caused small errors?

- **Human error** – Maybe the line up of the ruler wasn't perfect and the reading was slightly off.
- **Surface issues** – If the object didn't roll in a straight line, that could change the results.
- **Slipping** – If the object slid even a little instead of rolling smoothly, the distance would be off.

It's like when you roll a ball on the floor. If it wobbles, slides, or doesn't go in a perfect straight line, it won't land exactly where you expected.

- *What are some applications of this measuring technique? Could this measuring system be used to measure surfaces that are not flat?*

  Answer:

Rotary encoders aren't just for school projects. They're used everywhere:

- **Automobiles** – Detecting wheel rotations for anti-lock braking systems (ABS).
- **Elevators** – Helps in controlling the position of elevator doors and tracking floor levels
- **Vacuum Robots** – Helps navigate rooms by tracking wheel movements and measuring distance traveled.
- **Gaming Controllers** – Found in joysticks and steering wheels to detect fine movements for better gaming experiences.
- **Drones** – Assists in stabilizing flight and detecting propeller rotation.
- **Medical Devices** – Used in robotic surgery equipment, MRI machines, and prosthetic limbs for precise movement control.

Can It Work on Bumpy Surfaces?

Yes, but not as well. A flat surface gives the best results.
If the object rolls over bumps, dips, or curves, the measurements might be off.

What About Object Size?

- Big objects roll more smoothly and give better measurements.
- Small objects might slip or bounce, messing up the accuracy.

Imagine rolling a **basketball vs. a marble** on the sidewalk. The **basketball stays steady**, but the **marble might wobble** or get stuck in cracks.

Rotary encoders are **everywhere**, from everyday tech— **gaming controllers, smart home devices, roller skates** to **high-tech industries** like **robotics, and medicine**. Their ability to **measure precise movement**

Project Part 6

Observing the Hall Effect

In this part of the project, we studied how **magnetic fields can be detected using the Hall effect sensor.** Instead of working with the sensor directly, we analyzed data to see how the sensor measures changes in magnetic field strength.

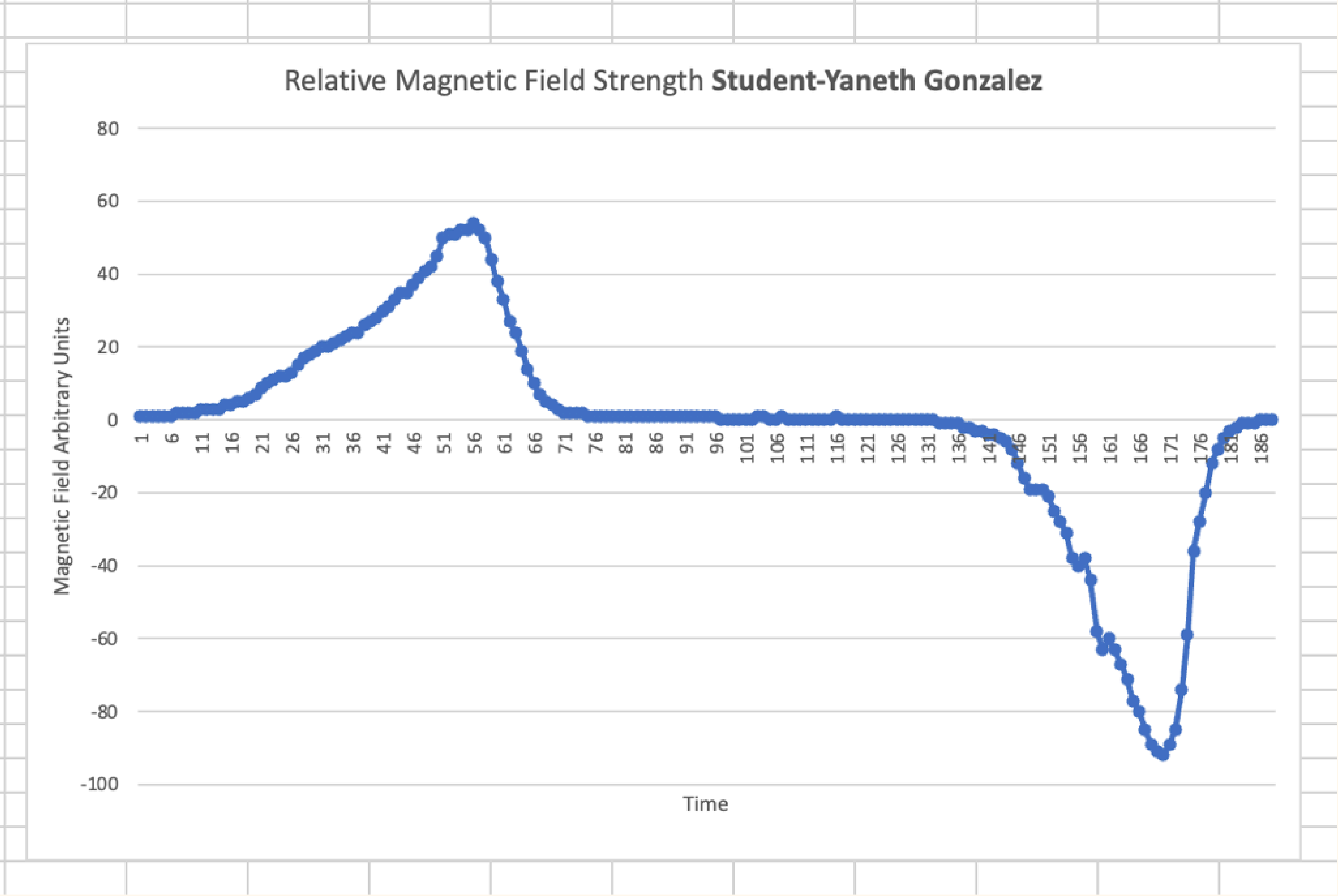
We examined an **Excel graph that showed how the magnetic field changed over time. As a magnet moved closer to the sensor, the values increased, and when it moved away, the values dropped.** A sharp dip into negative values showed when the magnet was flipped.

The **goal** of this part was to understand how the **Hall effect sensor works, see how it detects magnetic fields, and explore how this technology is used in real life, like in cars, phones, and medical devices.**

Excel Graph (Screenshot)

Include Excel graph for a single trial of data plotted as a function of time.

Must include your name in the title of the graph.



Conclusions

- ***Briefly describe and explain the results.***

  Answer:

The graph shows how the **magnetic field changed over time** as the magnet moved near the sensor.

- At first, the field was weak, but as the magnet got closer, the values increased, reaching a peak.
- Then, the numbers dropped as the magnet moved away. The big dip into negative values likely means the magnet was flipped, changing its polarity.

This experiment shows how the **Hall effect sensor detects the strength and direction of a magnetic field**.

It helps track movement, position, and flips of a magnet in real-time.

- ***Describe how the Hall sensor works. What are some applications for the Hall effect sensor?***

  Answer:

A **Hall sensor** works by detecting magnetic fields.

When a magnet gets close, it creates a tiny electrical signal that tells us how strong the field is and whether the magnet's north or south pole is facing the sensor.

This sensor is used in everyday technology, like:

Cars:
- It helps track speed and engine position.
- Used in wheel speed sensors, camshaft position sensors, and throttle position sensors.

Phones & Laptops:
- Detects when a screen closes or a flip cover is used.
- Found in smartphones for detecting flip covers and in keyboards for contactless switching.

Factory Machines:
- Helps control moving parts and ensure things run smoothly.
- Used in brushless DC motors and conveyor belt speed detection.

Medical Devices:
- Used in imaging tools and prosthetics.
- Incorporated in medical imaging machines and certain prosthetics.

Hall sensors are everywhere, quietly helping things work behind the scenes.

Challenges

Throughout this project, I faced challenges in understanding the given data and applying the right physics concepts to analyze it.

Learning physics in general was also challenging, especially when working with formulas. Understanding concepts like **acceleration, velocity, energy conversion, and rotational motion required careful study to apply the right equations.** Some formulas had multiple steps, and it was easy to make small mistakes in calculations.

Additionally, real-world factors like air resistance, friction, and sensor limitations caused differences between the expected and actual results. **This made it important to think critically about why certain numbers didn't match perfectly with theoretical values.**

Despite these challenges, this project helped me build **problem-solving skills, improve my understanding of physics, and see how it connects to real-world technology.**

Career Skills

Learning physics in **Tech 204** and working through **Projects 1 to 6** helped me build important skills for **my cybersecurity majo**r. Physics teaches problem-solving, critical thinking, and data analysis, which are also key in **cybersecurity when analyzing networks, detecting threats, and troubleshooting issues.**

Each project helped me work with formulas, calculations, and data interpretation. For example, in **Project 1 (Speed of Sound) and Project 3 (Gravity), I had to understand sensor data and apply the right formulas, just like in cybersecurity when analyzing security logs or network activity. Project 5 (Rotational Motion) and Project 6 (Hall Effect) taught me how sensors track movement, similar to how cybersecurity tools track digital activity and security threats.**

Using Excel for data collection and analysis also relates to cybersecurity, where tracking and interpreting data is important for system security. These projects helped me **improve my logical thinking, problem-solving, and attention to detail, which are skills I'll need in my future cybersecurity career.**

Conclusion

Taking **Tech 204**, gave me a better understanding of physics and how it applies to real-world problems. Learning the formulas and concepts was challenging, but working through each project helped me **improve problem-solving, data analysis, and critical thinking skills.**

These projects showed me **how to collect and interpret data, understand motion, and apply scientific methods**. Even though physics was difficult at times, breaking it down into hands-on experiments made it easier to grasp.

Overall, t**his course strengthened my ability to think logically and solve problems, which will be valuable in any technical field.** It showed me how physics connects to everyday life and technology in ways I hadn’t realized before.

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Thank You!

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