Physics Laboratory Report

Lab number and Title: Lab 109 – One Dimensional Motion and Velocity as a Function of Time and Distance at Constant Acceleration

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Course & Section Number: PHYS111A - 011 **Instructor's Name: Professor Nguyen**

Partners' Names: Logan Chappel, Jose Tabuena, Connor Nguyen

1. INTRODUCTION

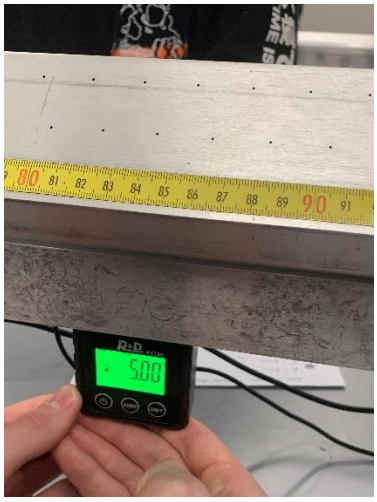
This experiment has us drop a block down a near frictionless surface to determine velocity, acceleration, and displacement. Our objective was to use the data we collected, as well as our knowledge of the kinematic formulas to get the same acceleration value for all three methods of finding acceleration (kinematics formula, sin theorem, tangent line). In part one, we have three experiments, each with three test runs of their own, with the displacement value between the two photogates being changed. This is meant for us to have a better average of the acceleration since there are environmental factors that may affect a small sample size. As for part two, we run two tests where we tracked the movement of another object using a motion sensor. We had to determine the acceleration using that method too and compare it to the other ways we had solved for in part one.

1 EXPERIMENTAL PROCEDURE

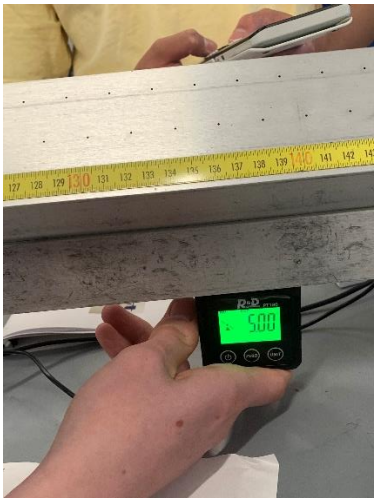
Part One

The procedure is written inside the lab manual. We followed all steps as stated in the manual.

We confirmed that the setup was at an angle of 5 degrees at three points.



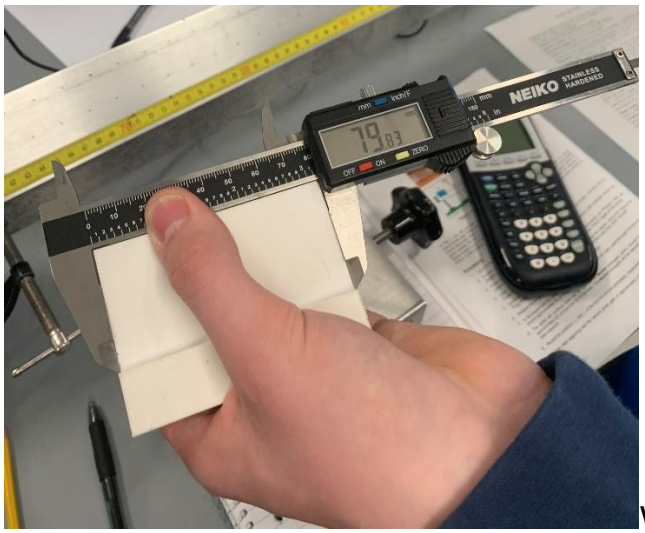
At Point 85cm



At Point 137cm

At Point 161cm

We also measured the size of the object, which can be used in the kinematics formulas.

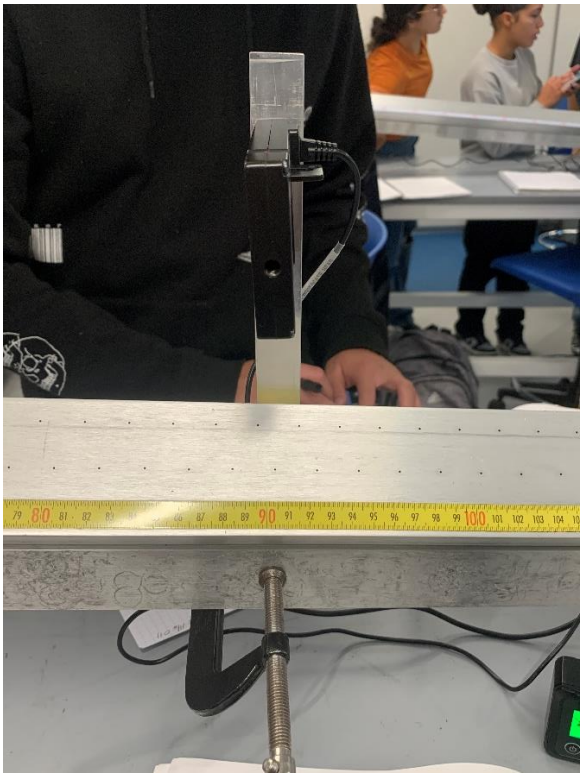


Written: 79.83 mm

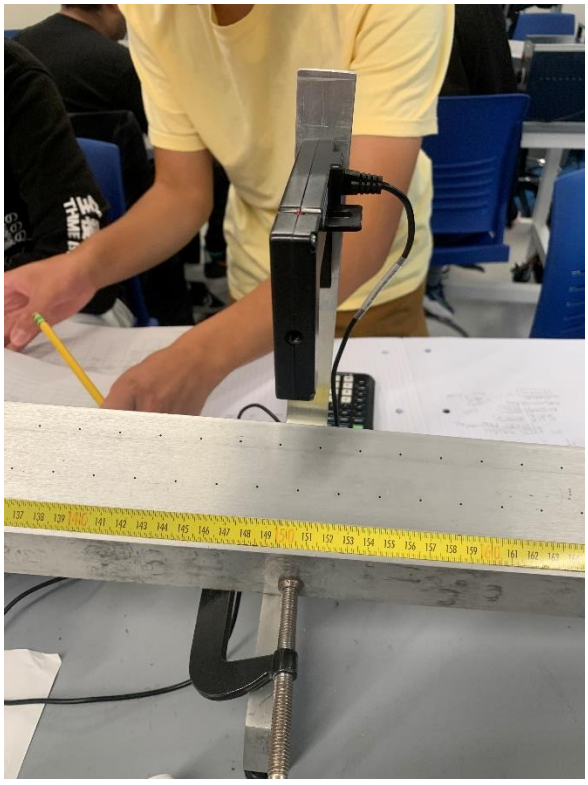
Lastly, we set the placement of the photogates. Photogate one remained in place through all three experiments, but photogate two had been moved to three separate distances to calculate an average.

Location of Photogate 1 During All Three Experiments [30cm]

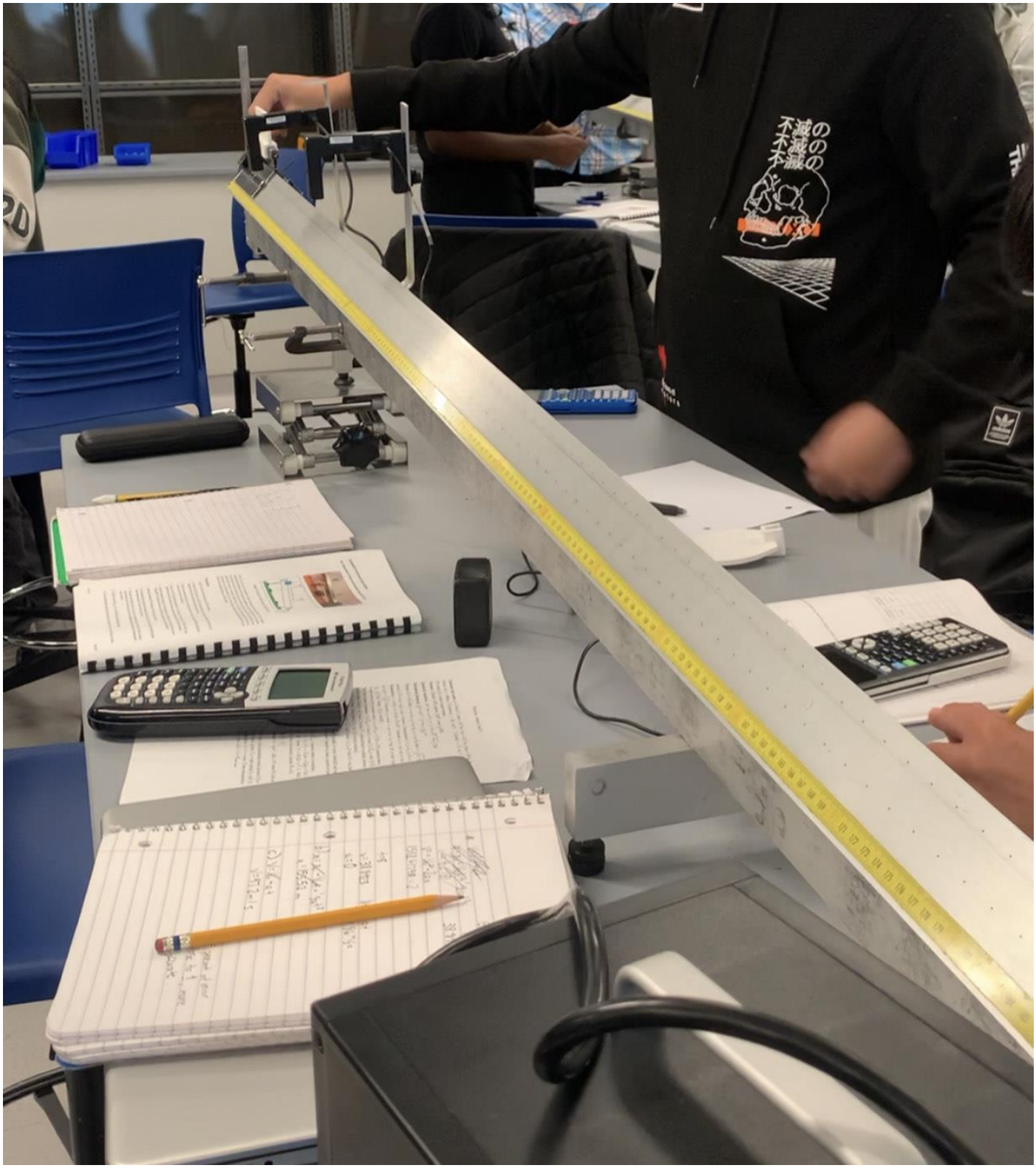
Location of Photogate 2 During Experiment One [60cm]



Location of Photogate 2 During Experiment Two [90cm]

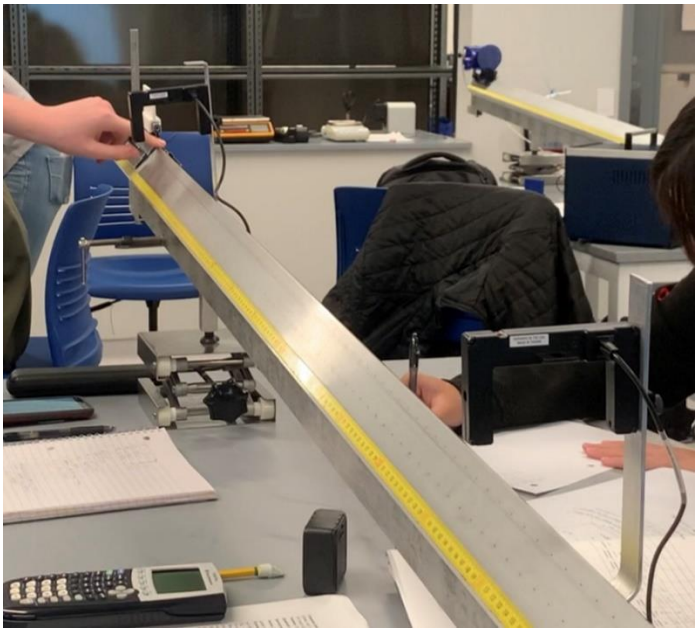


Location of Photogate 2 During Experiment Twp [150cm]



Full setup of part one, experiment one.

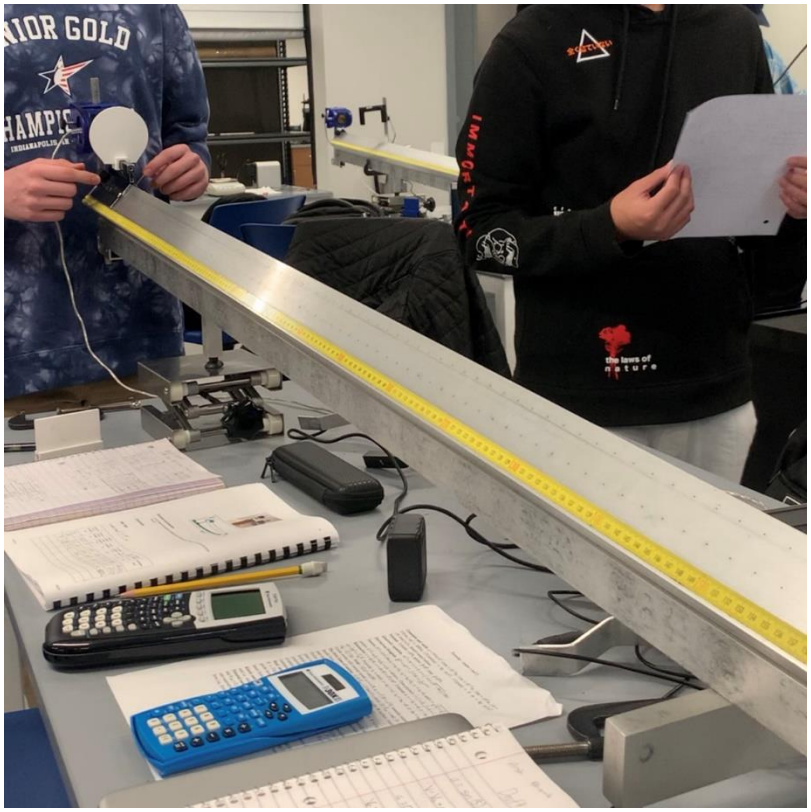
Setup of Experiment Two



Setup of Experiment Three

Part 2

For part two, the photogates are removed and instead replaced with the motion sensor. It tracks the movement and acceleration of the object as it goes down the slope. This value was tracked onto the software that was given to us on the computer. The time at the start where the displacement and velocity are 0 are not counted in the actual value.



2 RESULTS

Length of Flag: 0.0079m

Position of 1st Photogate [m]	Position of 2nd Photogate [m]	Distance Between P1 - P2 [m]	Time at P1 [s]	Time at P2 [s]	Time Between P1 – P2 [s]	Velocity at P1 [m/s]	Velocity at P2 [m/s]	Acceleration [m/s^2]
0.30	0.60	0.30	0.1295	0.0829	0.4068	0.6177	0.9644	0.8522
0.30	0.90	0.60	0.1294	0.0660	0.6418	0.6182	1.211	0.8577
0.30	1.5	1.2	0.1299	0.0502	1.128	0.6154	1.594	0.8692

Arsh Bhamla

Calculations

Experiment One

$V = V_0 + at \rightarrow V - V_0 = at \rightarrow a = \frac{V - V_0}{t}$

$a = \frac{0.9644 - 0.6177}{0.4068}$ $\quad a = 0.852\ m/s^2$

Experiment Two

$V = V_0 + at \qquad a = \frac{V - V_0}{t}$

$a = \frac{(1.2118) - (0.6182)}{(0.6418)}$ $\quad a = 0.858\ m/s^2$

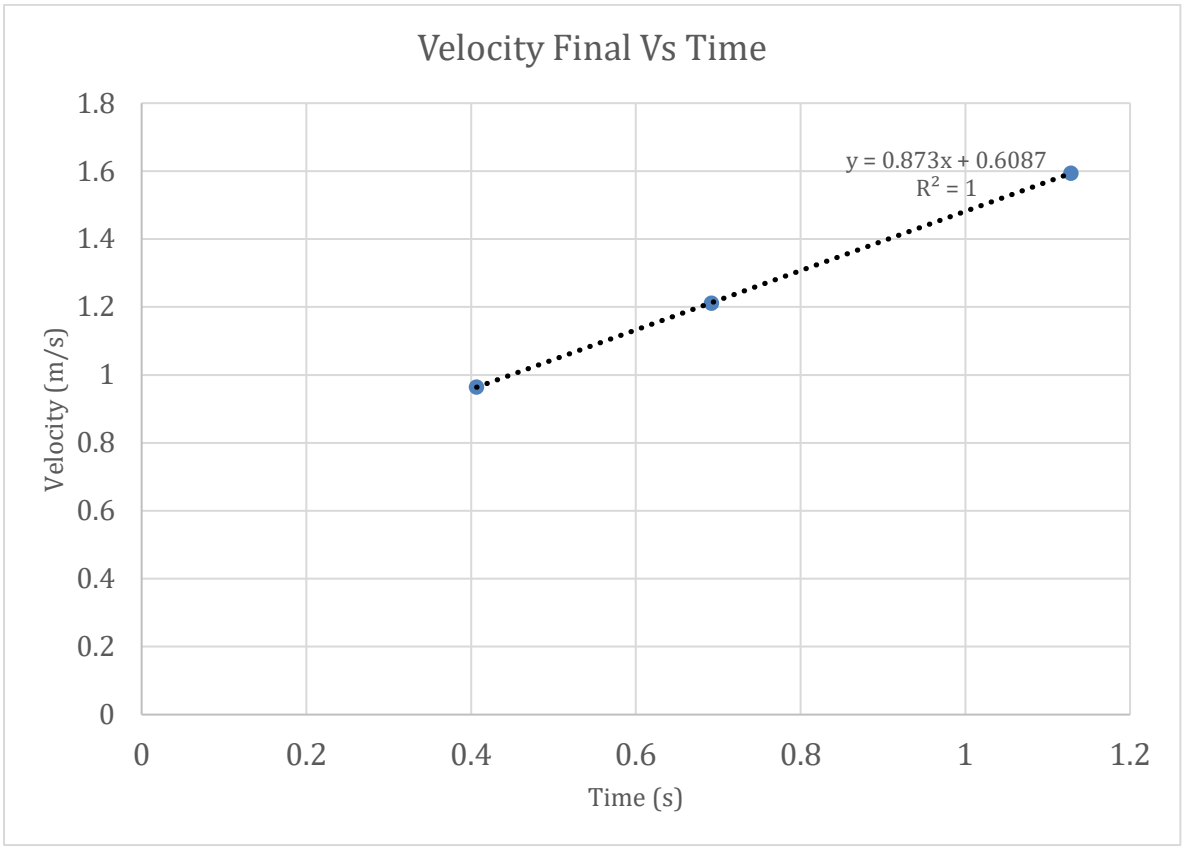
Experiment Three

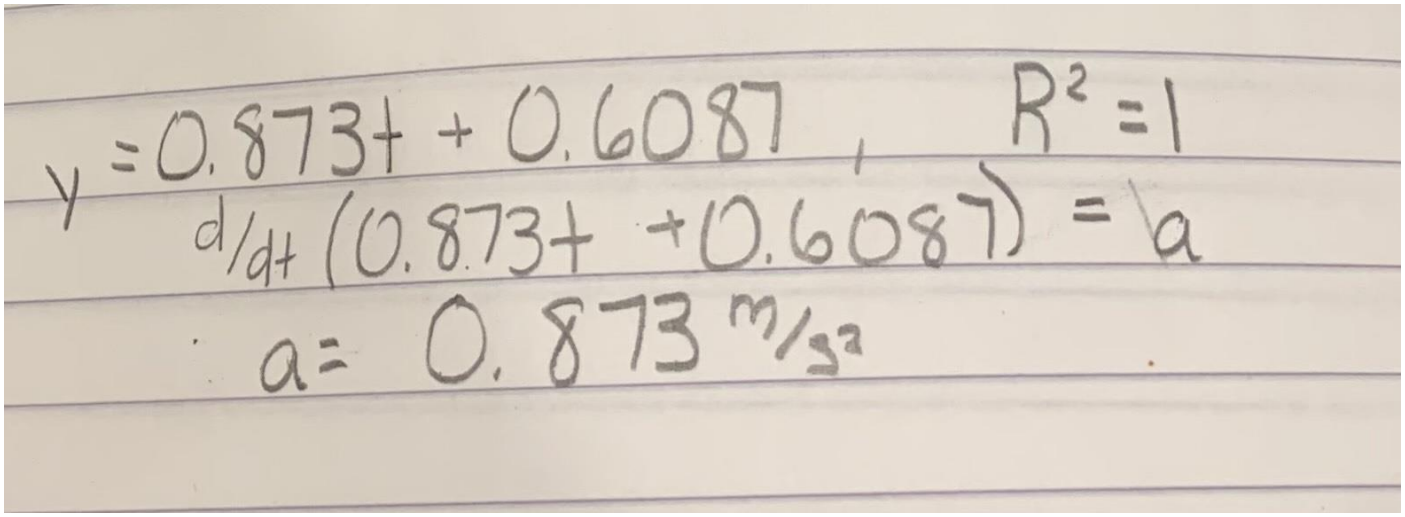
$V = V_0 + at \qquad a = \frac{V - V_0}{t}$

$a = \frac{(1.5943) - (0.6154)}{1.1285}$ $\quad a = 0.869\ m/s^2$

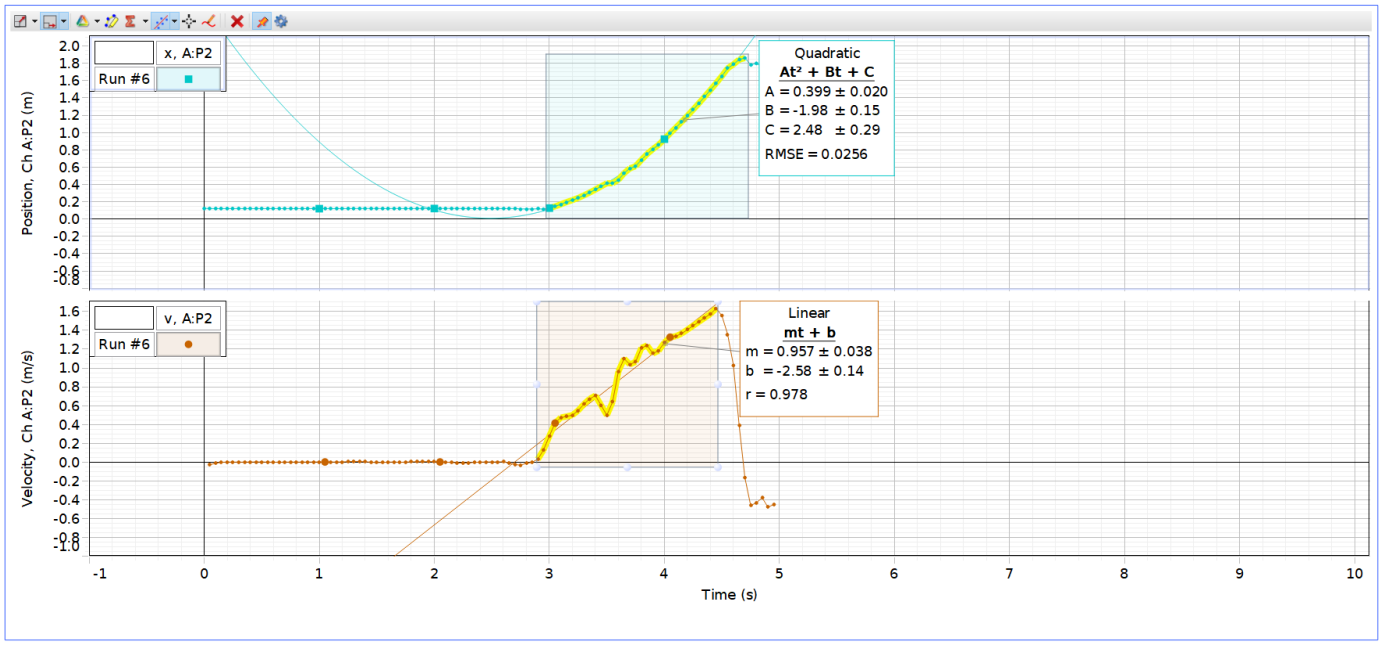
$a = \sin(\theta)\, g \qquad (a = \sin(5°)(9.8)$

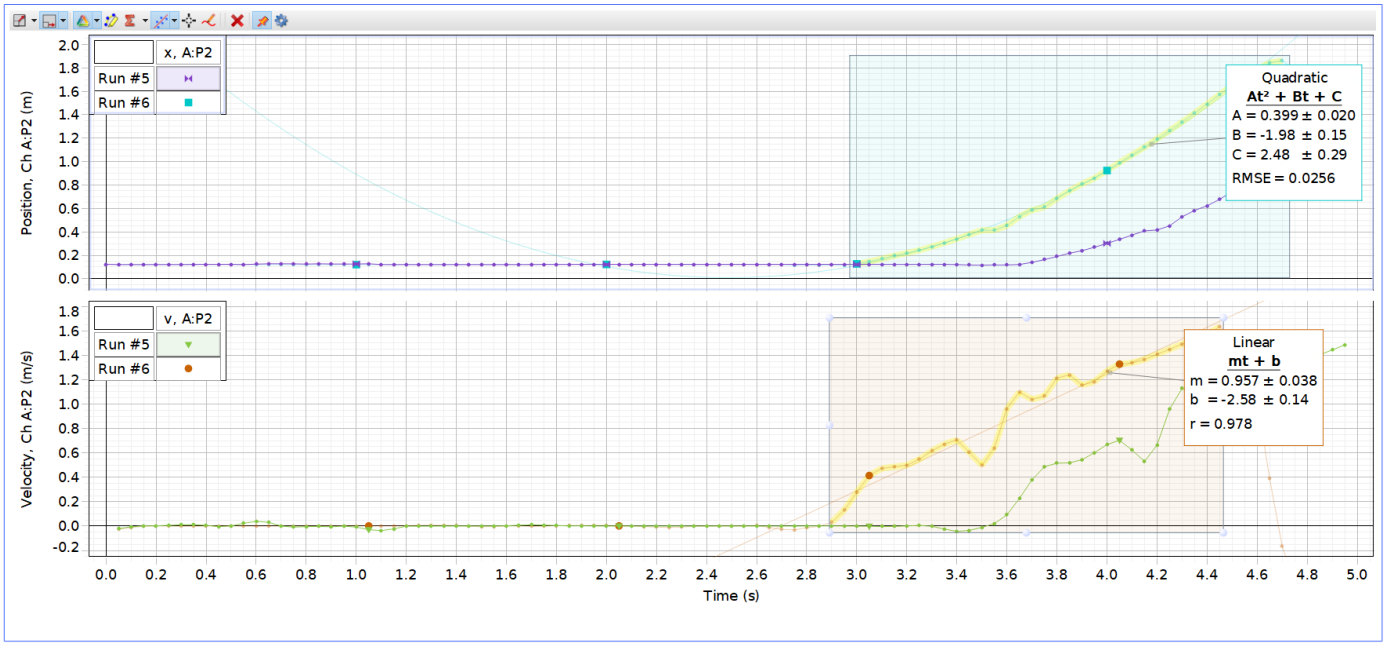
$a = 0.854\ m/s^2$

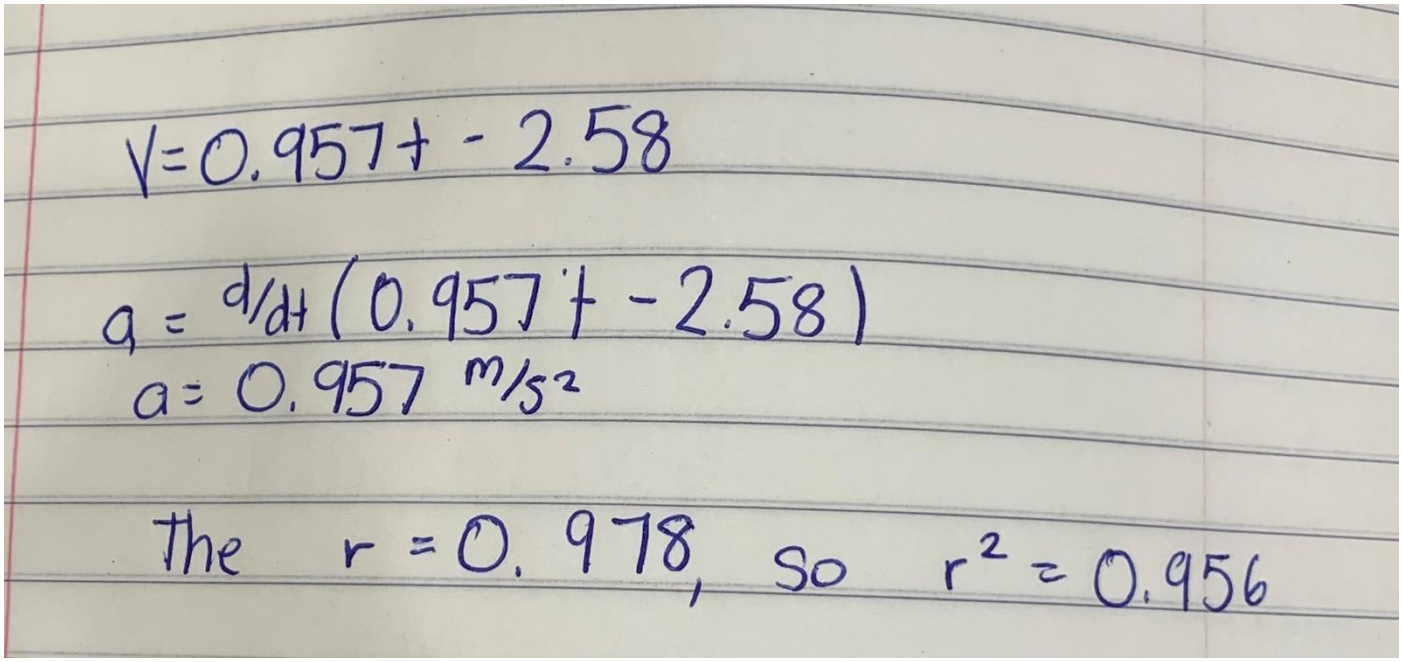

Velocity Final Vs Time
y = 0.873x + 0.6087
R² = 1
Velocity (m/s)
Time (s)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2


y = 0.873t + 0.6087, R² = 1
d/dt (0.873t + 0.6087) = a
a = 0.873 m/s²

Part Two


x, A:P2
Run #6
Quadratic
At² + Bt + C
A = 0.399 ± 0.020
B = -1.98 ± 0.15
C = 2.48 ± 0.29
RMSE = 0.0256
Position, Ch A:P2 (m)
v, A:P2
Run #6
Linear
mt + b
m = 0.957 ± 0.038
b = -2.58 ± 0.14
r = 0.978
Velocity, Ch A:P2 (m/s)
Time (s)


x, A:P2
Run #5
Run #6
Quadratic
At² + Bt + C
A = 0.399 ± 0.020
B = -1.98 ± 0.15
C = 2.48 ± 0.29
RMSE = 0.0256
Position, Ch A:P2 (m)
v, A:P2
Run #5
Run #6
Linear
mt + b
m = 0.957 ± 0.038
b = -2.58 ± 0.14
r = 0.978
Velocity, Ch A:P2 (m/s)
Time (s)



3 ANALYSIS and DISCUSSION (20 points)

For part one, we used the most basic kinematics formula (V = Vo + at) in order to solve for acceleration since we had the velocity values at both areas given to us for part one. To confirm we were correct, we used the sin(theta)g equation that was introduced to us in class. It allowed us to confirm our values since they are similar (with differences less than $0.01 m/s^2$). Lastly, when we created the tangent line on excel, we were given the error analysis in $R^2 = 1$. That means that we have an insignificant error percentage.

As for part two, we were able to determine the acceleration using the velocity formula that they gave. The bottom graph that was given was the velocity in relation to time, which we know we can use the derivative to get the acceleration. This gave an answer that was slightly far from the other ones, but that makes sense considering the R^2 was 0.956. That means there is slight variation that must be accounted for. The values I was given are quite consistent with the theoretical acceleration (which was calculated using the sin(theta)*gravity. However part two had a higher error percentage, hence why it was off.

4 CONCLUSIONS (10 points)

We learnt about acceleration and its correlation with velocity, displacement, and time. We used multiple methods to solve the acceleration, and then were able to compare all of them to get a trend that neared the theoretical answer. If we were to do this again, I would try finding a new variable, or find new methods of finding acceleration through different

experiments. I would recommend that a set time for part 2 to make sure there isn’t any variety in the data sets since we held it up for multiple seconds.