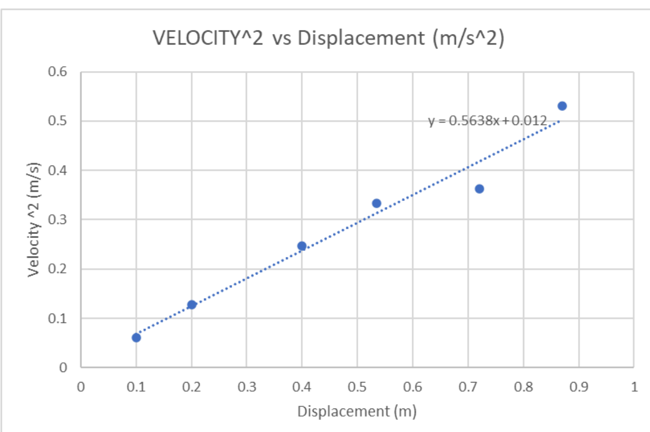
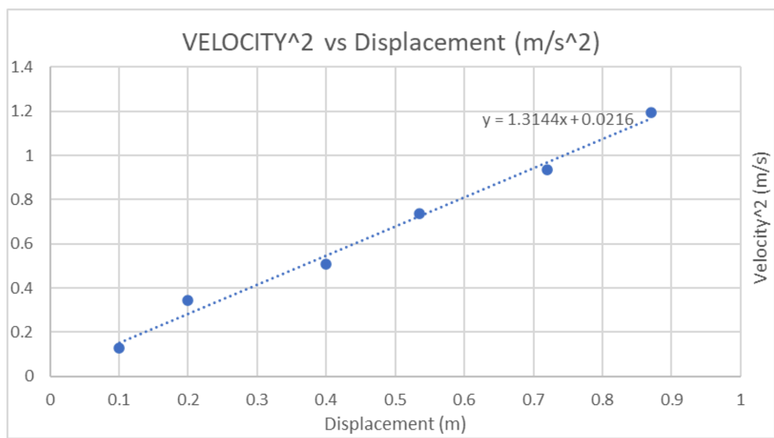
Linearizing Graphs

1. In order to identify the acceleration of the carts, a linear graph must be created from the measured variables, and the slope must be identified.
2. The relationship between the variables from the data–a distance vs velocity graph–is not linear. Therefore, the relationship must be altered so that the expression graphed on the x and y graph is linear. This can be done as following:
    a. As the graph is comparing the relationship between velocity and distance, the no t equation can be employed, as time does not play a role. The equation follows as: $v^2 = v0^2 + 2a\Delta x$. Because the starting velocity is at rest, $v^2 = 2a\Delta x$. A linear relationship to graph can now be identified, with a linear graph of Δx vs v^2 on the x and y-axis, respectively. This relationship can be used for both inclines.



Incline One



Incline Two

$y = 0.5638x + 0.012$

$v^2 = 2a\Delta x$
$v^2 = 0.5638\Delta x$

$y = 1.3144x + 0.0216$

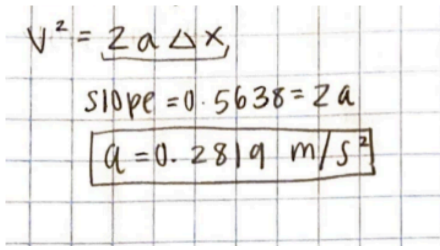
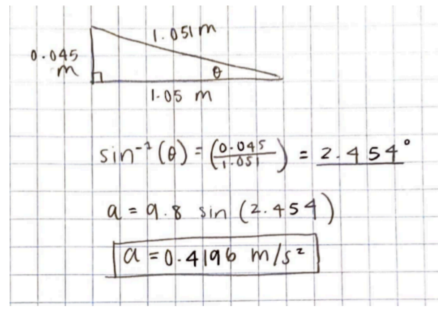
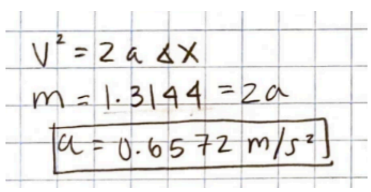
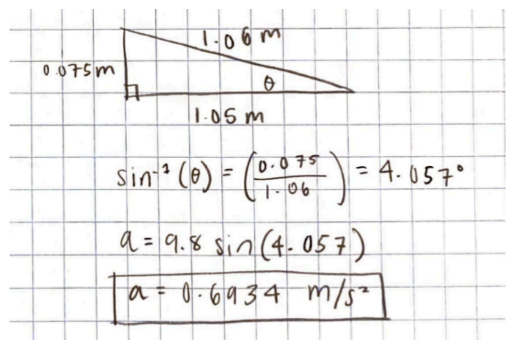
$v^2 = 2a\Delta x$
$v^2 = 1.3144\Delta x$

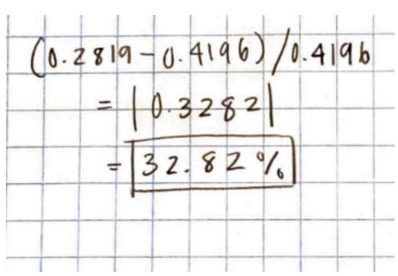
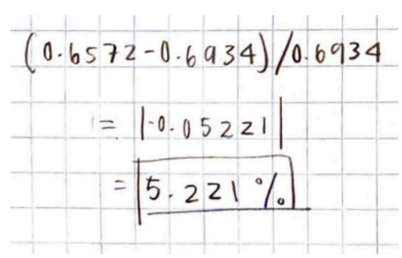
Finding Acceleration (Experimental and Expected)

For finding the experimental acceleration, the above relationship has a slope of $2a$, indicating simply dividing the slope by two equals the experimental acceleration.

The expected acceleration can be derived by:

1.) Finding θ using sin^{-1} (opp/hyp)
2.) Plugging θ into given expected value equation
    a.) $a = 9.8sin(\theta)$

<table>
<tr><th></th><th>Experimental Acceleration m/s2</th><th>Expected Acceleration (m/s2)</th></tr>
<tr><td>Incline 1</td><td>
$a = 0.2819\ m/s2$</td><td>
$a = 0.4196\ m/s2$</td></tr>
<tr><td>Incline 2</td><td>
$a = 0.6572\ m/s2$</td><td>
$a = 0.6934\ m/s2$</td></tr>
</table>

<table>
<tr><th></th><th>Incline 1</th><th>Incline 2</th></tr>
<tr><td>Percent Error %</td><td></td><td></td></tr>
</table>

	32.82%	**5.221%**

Sources of Error:

The experimental values of incline 1 and 2 were $a = 0.2819\ m/s2$ and $a = 0.6572\ m/s2$, respectfully. The expected values were $a = 0.4196\ m/s2$ and $a = 0.6934\ m/s2$, resulting in a percent error of 32.8% and 5.221%, respectfully.

The velocity sensor used to measure and read the velocity of the cart likely acted as a source of error. Directioning the cart in alignment with the sensor to get consistent results was nearly impossible, which accounted for errors in the calculated velocity, altering the acceleration. Also, in the release of the cart, shaky hands created force and altered the speed accounted for in the expected value. Friction from the cart also played a role in creating differentiated results, as it slowed the motion of the cart. This friction wasn't accounted into the calculations for the expected value, explaining why the acceleration on both inclines is slower than expected. Finally, it is important to acknowledge the Track wasn't smooth, which accounted for error in velocity readings through the sensor.