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Acceleration on an Inclined Plane Lab

Due 9/20/23

Data Analysis

Linearizing Graphs

In order to linearize the graphs, you must make the equation into y=mx+b. This means given the original equation of $v^2 = v_0^2 + 2a\Delta x$, you can first take out the initial velocity as it is 0, making the equation $v^2 = 2a\Delta x$, then if you take the square root of both sides, you would get $v = 2a\sqrt{\Delta x}$. Then, to make the equation into y=mx+b, you must make $\sqrt{\Delta x}$ into the x-axis unit.

Data Tables

Distance (m)	Velocity 1 (m/s)	Velocity 2 (m/s)	Velocity 3 (m/s)	Average velocity (m/s)
0.1	0.164	0.169	0.178	0.170
0.2	0.235	0.234	0.278	0.249
0.4	0.364	0.357	0.359	0.360
0.5	0.398	0.373	0.389	0.387
0.6	0.447	0.414	0.423	0.428
0.8	0.486	0.516	0.489	0.497

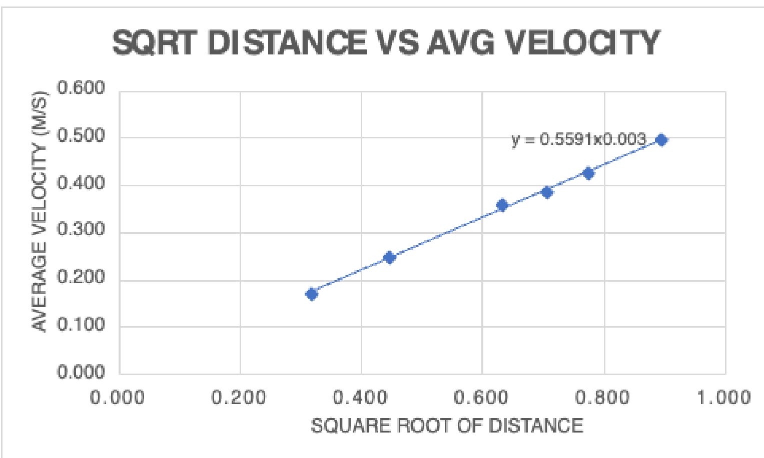
Incline 1

Distance (m)	Velocity 1 (m/s)	Velocity 2 (m/s)	Velocity 3 (m/s)	Average velocity (m/s)
0.1	0.353	0.355	0.342	0.350
0.2	0.469	0.489	0.474	0.477
0.4	0.681	0.684	0.677	0.681
0.5	0.79	0.767	0.758	0.772
0.6	0.846	0.836	0.805	0.829
0.8	0.967	0.957	0.962	0.962

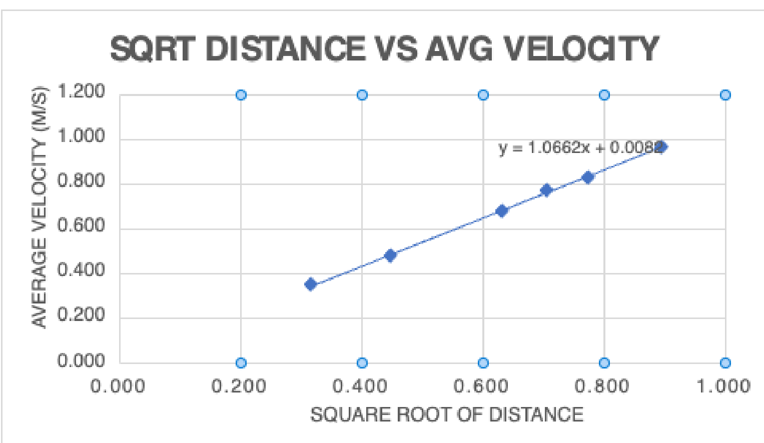
Incline 2

Graphs

Incline 1



Incline 2



Line of Best Fit

After having Excel calculate the line of best fit, there will be a b value left over. For the purposes of this experiment, we set this equal to 0 because we want to assume that there is no v_0 value. Then, to calculate the line of best fit in terms of v and Δx, you would substitute v for y and Δx for x, according to the equation manipulated above, $v = 2a\sqrt{\Delta x}$. The two equations would then be the following:

Incline 1: $v = 0.5591\sqrt{\Delta x}$

Incline 2: $v = 1.0662\sqrt{\Delta x}$

Conclusion

Observed Acceleration

In order to find the experimental acceleration, you would plug in the slope into the equation m=2a. This is derived from the equation $v = 2a\sqrt{\Delta x}$, where 2a is representative of m (or the slope). After you make the appropriate equations, you simplify them to find a. In this case, round to the nearest thousandth place. The equations and answers for the 2 inclines are below:

Incline 1: $2a = 0.5591$

$a = 0.280$ m/s^2

Incline 2: $2a = 1.0662$

$a = 0.533$ m/s^2

Expected Acceleration

The equation for acceleration is $a = g \times sin(\theta)$. The first incline has a calculated θ value of 2.25° and the second incline has a calculated θ value of 4.5°. G has a previously established value of -9.8m/s^2, but for this experiment you will keep it positive as the downward slope is considered increasing gravity (acceleration). Then, to calculate the expected acceleration of each incline, you use the equation $a = g \times sin(\theta)$ and substitute g for 9.8 and θ for the appropriate angle and solve, and round the answer to the nearest thousandth to match the previous acceleration values. The equations for the two inclines are below:

Incline 1: $a = 9.8 \times sin(2.25)$

$a = 0.385$ m/s^2

Incline 2: $a = 9.8 \times sin(4.5)$

$a = 0.769$ m/s^2

Percent Error

In order to find the percent error, you use the equation $\frac{observed - expected}{expected} \times 100$. In this case, the observed and expected values for incline 1 would be 0.280 m/s^2 and 0.385 m/s^2, respectively. For incline 2, the observed and expected values would be 0.533 m/s^2 and 0.769 m/s^2, respectively. The equations for the two inclines are shown below:

Incline 1: $\frac{0.280-0.385}{0.385} \times 100$ = -27.28%

Incline 2: $\frac{0.533-0.769}{0.769} \times 100$ = -30.69%

Sources of Error

The percent errors were achieved by rounding the accelerations to the nearest thousandth place. If the original numbers were kept then there would be a very small change in the percent error, providing one source of error. The expected acceleration is also an estimate, so therefore the number used to represent this value is exactly correct in real life, it is just “roughly” correct. Other sources of error could include rounding while collecting the data, differences in cart starting distance from the sensor, the position of the screw sticking out of the cart when it passes the sensor, and the cart presenting extra friction. Since both percent errors are negative, that means the observed values were below the expected acceleration, further supporting the possibility of friction caused by the cart or air resistance from the cart. Any source of error would most likely cause the acceleration to lower, therefore causing the percent error to be increasingly negative. While doing the data analysis, one source of error would include excluding the y-intercept from the original lines of best fit (staring velocity, a possibly extra push when letting go of the cart). While they may be under 0.01, they still present a source of error.