1 • Results

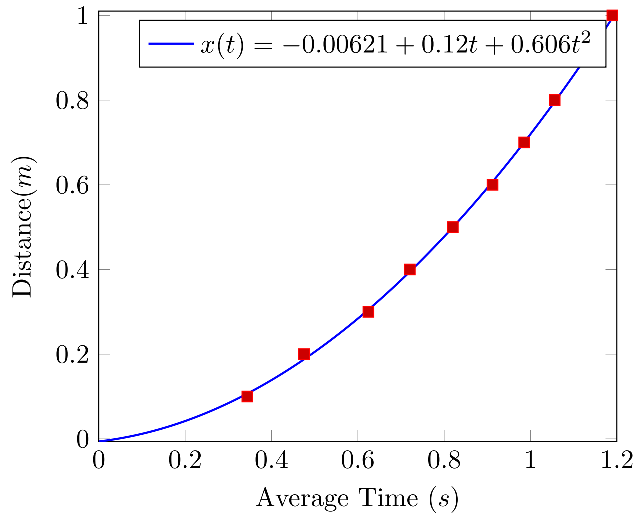

Figure 1: The average time of three trials it took the cart to travel each distance, along with a polynomial approximation $x(t)$ of the position function of the cart.

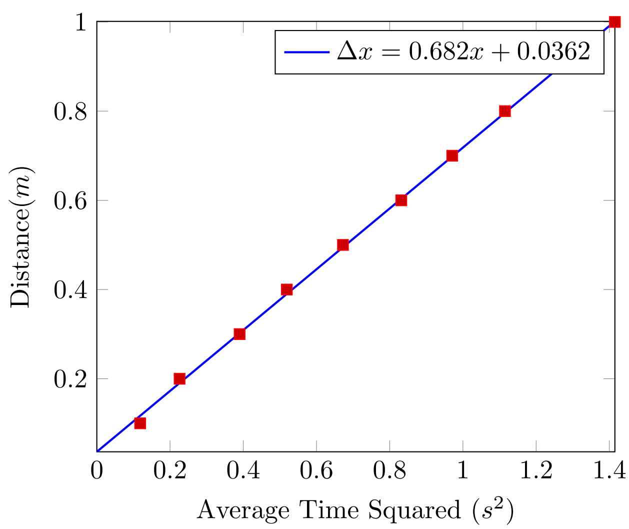

Figure 2: The average time squared of three trials it took the cart to travel each distance, along with a linear approximation of the graph.

2 • Analysis

2.1 Slope of Linearized Position Graph

The kinematics equation most suited to being linearized to use to find acceleration is as follows:

$$\Delta x = v_0 t + \frac{1}{2}at^2$$

Since our starting point was defined as our zero point and initial velocity v_0 was close to zero, the equation can be rewritten as a position function of time t as follows:

$$\Delta x = \frac{1}{2}at^2$$

By graphing t^2 on the x-axis and Δx on the y-axis, as is done in Figure 2, the slope of the graph is $\frac{1}{2}a$, so doubling the slope would result in the value of a. The slope of the graph in Figure 2 is $0.682\frac{m}{s^2}$, thus the acceleration derived from that graph is $1.364\frac{m}{s^2}$.

2.2 Derivatives of Polynomial Position Function

The polynomial approximation of the position function is as follows:

$$x(t) = -0.00621 + 0.12t + 0.606t^2$$

Taking the first derivative, we obtain the velocity function:

$$v(t) = 0.12 + 1.212t$$

Taking the second derivative, we obtain the acceleration function:

$$a(t) = 1.212$$

The acceleration function is constant, meaning the cart experienced a uniform acceleration of $1.212\frac{m}{s^2}$ as it traveled along the ramp.

2.3 Derivatives of Linearized vs. Polynomial Position Functions

The accerelation obtained using the linearized graph was $1.364\frac{m}{s^2}$, and the acceleration obtained from the polynomial position graph was $1.212\frac{m}{s^2}$. These numbers are fairly close, indicating the value of the cart's acceleration along the ramp is close to those quantities.

2.4 Possible Improvements to Lab

If we were to redo our lab to improve our results, there would be a few improvements we would make to our methodology to achieve that goal. Firstly, we would strive for more consistency in the release of the cart on the ramp. A few times, our cart was a little farther behind the photogate than we would've hoped for, meaning the cart did have slight velocity when passing through it. There were also some instances where a little force was applied to the cart, also slightly increasing its starting velocity, so reducing that would also be a goal if this lab were to be repeated. Collecting more data points per distance would also be helpful in increasing the accuracy of our acceleration values.

A • Data

Distance (m)	Trial 1 (s)	Trial 2 (s)	Trial 3 (s)	Average Time (s)	Average Time Squared (s^2)
0.100000	0.345882	0.334001	0.352501	0.344128	0.118424
0.200000	0.440713	0.491477	0.494068	0.475419	0.226024
0.300000	0.630289	0.616555	0.626738	0.624527	0.390034
0.400000	0.710778	0.724504	0.725794	0.720359	0.518917
0.500000	0.819919	0.827310	0.812670	0.819966	0.672345
0.600000	0.914033	0.902782	0.919066	0.911960	0.831672
0.700000	0.996652	0.980317	0.979016	0.985328	0.970872
0.800000	1.063803	1.052296	1.051532	1.055877	1.114876
0.900000	1.145516	1.115298	1.133986	1.131600	1.280519
1.000000	1.186681	1.188571	1.193533	1.189595	1.415136