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PHYS170 Section1
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Motion Lab

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EXAMPLE
LAB
REPORT

Measuring Velocity of Motion zero Acceleration Motion Lab

Theory

Velocity is the rate of change of position. It is calculated as,

Velocity = change of displacement / change in time

This relationship is the theoretical basis of this experiment. As a formula this can be written:

$$\vec{v} = \frac{\Delta \vec{x}}{\Delta t}$$

Discuss and describe any relevant equations.

The numerator is the displacement vector, **Δx** This is the vector directed from the initial position to the final position. The denominator, Δt, is difference in time that occurs between the two displacements (change in time).

One can make a plot of an object's motion by graphing position on the ordinate and time on the abscissa. One can draw a line between an initial position and time point and a final position and time point. The slope of this line, the rise over run, will be equal to the above equation. That is, the velocity is equal to the slope of a position vs. time graph.

This is the methodology followed in this laboratory. We will make several measurements of position and time for a cart that is moving on a track. In the first part of the lab we will observe uniform motion, meaning that the velocity should be constant. We predict that the position vs. time graph should be a straight line. In the second part we will apply a constant force to the cart and predict, therefore, that the motion will be non-uniform. In this case the plot of position vs. time will be curved. Since it is curved it will have a slope that changes over time, which corresponds to a changing speed.

Discuss what will be done in this lab to study the theory and make predictions

Application of Theory: When a person throws a bowling ball they are initially giving the ball velocity as they push on it, which will be non-uniform motion. After they let go, as the ball rolls, it will move with a constant velocity. (It will slow down some due to friction as it rolls.)

Application

Table 1. Measuring Instruments and Uncertainties

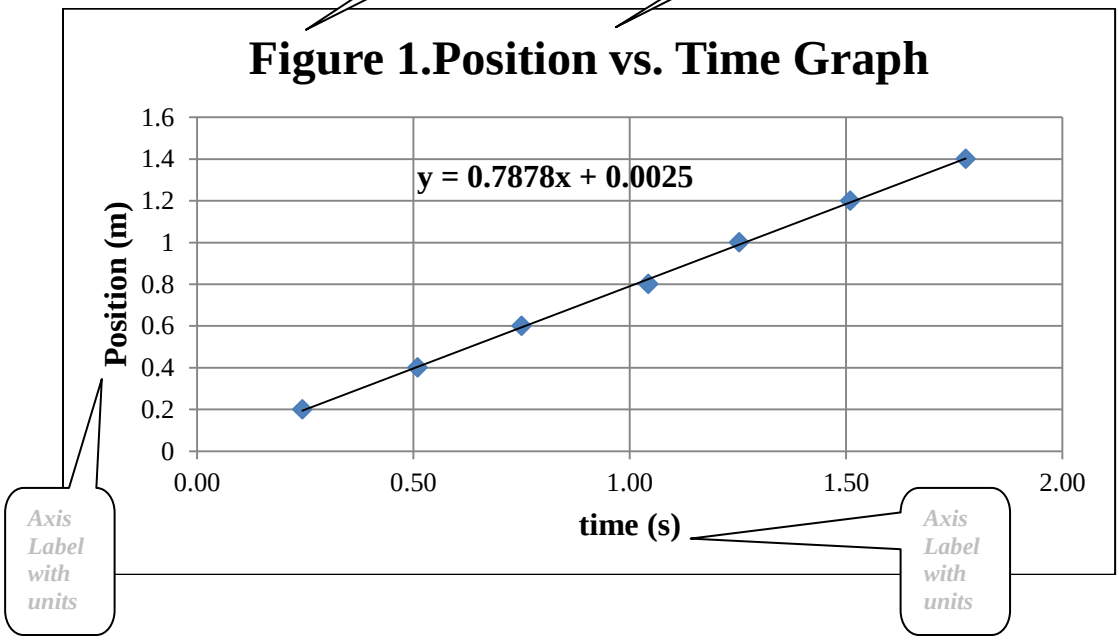
Variable	Description	Uncertainty (units)	Source of Uncertainty
t	Photogate timer – time of cart passage	0.1ms	Manufacturer limitation of the equipment
x	Ruler – displacement between the photogate timers	0.05cm	Least count of 0.1cm
x	Ruler – correct positioning of the photogate timers	0.5cm	Difficulty in determining the center of the timer

Data and Calculations

Table number *Table Title* *Column headers* *Units*

Table 1. Data for position and time.				
	Trail 1	Trail 2	Trail 3	
position: x (m)	time: t (s)	time: t (s)	time: t (s)	Mean: t (s)
0.2	0.26	0.23	0.24	0.24
0.4	0.49	0.54	0.5	0.51
0.6	0.74	0.75	0.76	0.75
0.8	1.02	1.08	1.03	1.04
1	1.2	1.29	1.27	1.25
1.2	1.5	1.54	1.49	1.51
1.4	1.76	1.8	1.77	1.78

Figure number *Figure Title*



Velocity = (slope from the graph) = ***0.79 m/s***

Raw Data

Table Raw Data for cart

X (m)	T1 t(s)	T2	T3	avg time s
.2	.26	.23	.24	.24
.4	.49	.54	.5	.51
.6	.74	.75	.76	.75
.8	1.02	1.05	1.03	1.04
1.0	1.2	1.29	1.27	1.25
1.2	1.5	1.54	1.49	1.51
1.4	1.76	1.8	1.77	1.78

uncert time 1 c .001 s ⇒ unc .00055 .5 ms

uncertainty .1 cm ⇒ .05 cm

position of timer 1 cm

Conclusion

Restatement of the objective

Objectives of this experiment included the conceptual objective of the experiment, where measurement the velocity of zero acceleration motion (motion without an applied force), and the experimental objective, where measurement of position as a function of time of a moving cart on low friction track, lead to the calculation of the velocity of the cart. At the conclusion of data collection and subsequent graphs followed by the analysis of slope lead to the evaluation of velocity of 0.79 ± 0.01 m/s.

Include Numerical results

Summary of the experimental results

Position vs. time data illustrates that the cart moved equal distances for equal time intervals implying no acceleration and constant velocity motion. Position vs. time graph was linear which suggests further, constant velocity motion.

Correlating the experimental results with theoretical expectations

As the track is nearly frictionless, experimental results are consistent with the theory as Newton's First Law where in the case of motion without the influence of a force (in this case either friction or another applied force) the cart will be either stationary or in motion at a constant velocity. Here the latter has been observed. The linear graph is the evidence of this particular motion.

Comment on possible deviations of experimental data from what is expected from the theory

There are four particular reasons the result may not be as accurate as desired. When placing the photogate timers on the track it was not possible to accurately estimate the exact position of the timer due to their inherent construction. This uncertainty cannot be avoided. Further, the experiment ignores the effects of friction between the cart and the track, however small this is not zero. Another factor is the resistance due to the air on the motion, which is also ignored and similarly this is also not zero. Of preceding two, the friction between the cart and track can have observable effects, as some defective wheels of certain carts may give rise to appreciable friction between wheel and the track. Third is the uncertainty of the photogate time measurements and the uncertainty if the positioning of the photogates measured by the meter ruler with least count uncertainty. Manufacturer's uncertainty for the photogates is recorded in the measuring instrument table with the least count uncertainty of the ruler. In this experiment, when considered all the uncertainties, frictional uncertainty should be dominant.

It will be interesting to perform the same experiment with a different setup, where the frictional uncertainty can be minimized. Perhaps a toy hovercraft without the horizontal propellant to negate the force should be a better alternative. Once the necessary velocity is reached this should represent the constant velocity motion better.