<u>*Powerful Outcomes*</u>
PHYS-130: College Physics I
MATH-132: Technical Math

<u>Laboratory One – Constant Velocity</u>

<u>Overview:</u>

This lab is intended to illustrate the relationship between displacement and time with respect to constant and non-constant velocity. The distance a glider moves on a frictionless air track will be measured as a function of time. If the position of the glider is proportional to time, t, then the relationship is linear, and a graph of the glider's motion (*position vs. time*) will yield a straight line. The slope, m, of the straight line is the rate of change in position, x, with respect to time, t. If the slope has a constant value, then the graph represents constant velocity.

If the *position vs. time* graph is not linear, then the velocity is not constant but changes at a varying rate with respect to time, and the graph (or portion thereof) represents acceleration.

<u>Instructions:</u>

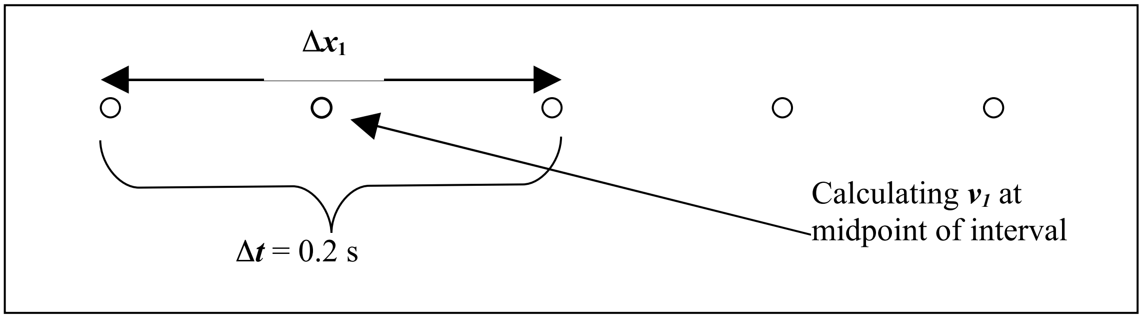
1. Level the air track and attach spark tape with masking tape. Be sure that the glider moves on the track unimpeded – no wires touching, etc.

2. Set the spark generator to 10 Hz. Start sparking! Give the glider a push, release it, and continue sparking until the glider reaches the end of the track. Do not continue sparking as the glider bounces back.

3. Remove the spark tape. Number the data points (spark holes) in sequence, starting at zero. Measure the **position,** x, of each spark hole in centimeters from the first (or zero) point. Complete the attached Data Table columns for spark number, time, and position, as shown in the example below, *indicating appropriate units.*

Data Point (Spark #)	**Time, t (s)**	**Position, x (cm)**	Δx	**Velocity, v**
0	**0**	**0**		
1	**0.1**	**2**		
2	**0.2**	**5**		
3	**0.3**	**10**		
4	**0.4**	**17**		

4. An estimation technique will be used to calculate the glider's velocity at each data point. It can be assumed that if the velocity is constant, or if the time base used is relatively small for a non-constant velocity, then a "mid-point", or average, velocity is a reasonable approximation of the actual velocity at each data point.



Calculate a **change in position, Δ*x*,** for each data point by measuring the distance between the point before and the point after. Enter the Δ*x* values in the Data Table as shown in the example below, again indicating appropriate units.

Data Point (Spark #)	**Time, *t* (s)**	**Position, *x* (cm)**	**Δ*x* (cm)**	**Velocity, *v***
0	0	0	**0**	
1	0.1	2	$\Delta x_1 = x_2 - x_0 =$ **5**	
2	0.2	5	$\Delta x_2 = x_3 - x_1 =$ **8**	
3	0.3	10	$\Delta x_3 = x_4 - x_2 =$ **12**	
4	0.4	17	**…**	

5. Determine the time interval between the point before and the point after (the time interval is constant for every set of points). Measure the average velocity during a time interval by dividing the change in position, Δ*x*, by the time interval. Enter the values in the data table as shown below; as always, indicate appropriate units and watch significant figures!

Data Point (Spark #)	**Time, *t* (s)**	**Position, *x* (cm)**	**Δ*x* (cm)**	**Velocity, *v* (cm/s)**
0	0	0	0	**0**
1	0.1	2	$\Delta x_1 = x_2 - x_0 = 5$	**Δx_1 / 0.2 s = 25**
2	0.2	5	$\Delta x_2 = x_3 - x_1 = 8$	**Δx_2 / 0.2 s = 40**
3	0.3	10	$\Delta x_3 = x_4 - x_2 = 12$	**Δx_3 / 0.2 s = 60**
4	0.4	17	…	**…**

LAB ONE: CONSTANT VELOCITY

DATA TABLE

Spark Frequency: ________________ Time Interval: ____________________

Data Point (Spark #)	**Time,** *t* **( )**	**Position,** *x* **( )**	Δx **( )**	**Velocity,** *v* **( )**

Data Analysis:

Graphing:

Using the data from the Data Table and EXCEL, plot a graph of *position vs. time*. Plot position, x, on the vertical axis vs. time, t, on the horizontal axis. The slope of this graph represents the rate of change of position with respect to time, or velocity!

Use a best-fit line or curve; your line or curve should not just "connect the dots". The graph should include proper scales and labels (including units) on each axis, as well as a title.

Plot a graph of *velocity vs. time*. Plot velocity, v, on the vertical axis, vs. time, t, on the horizontal axis. Again, include proper scales and labels on the graph and use a best-fit curve or line.

Questions:

Physics:

1. Indicate on both graphs, where the glider was pushed.
2. Did the glider move with a constant velocity when it was not being pushed? Indicate constant velocity on both graphs.
3. When did the glider have maximum velocity? Indicate maximum velocity on the *velocity vs. time* graph. What was the maximum velocity?
4. Should maximum velocity have been maintained in a frictionless environment? Did the air track eliminate all or most of the friction in this experiment? Does either graph indicate friction in any way?
5. Find the slope of the *position vs. time* graph in the constant velocity region. According to the graph, what is the magnitude of the slope? Does this magnitude agree with the magnitude of constant velocity on the *velocity vs. time* graph? Indicate on the graphs.

Math: Use the position vs. time graph.

1. Identify where the slope formula is used.
2. What is the relationship between the slope and constant velocity?
3. Identify the domain.
4. Identify the range.
5. Where does the graph become linear?
6. Given the constant velocity, create a linear position function and find the position of the object at 3s, 5s, and 10s.

Submission:

Include graphs, EXCEL data sheet, and your lab data sheet, along with any lab notes, etc., in your "report". A proper cover sheet should be included also. Refer to the grading rubric and "Lab Report Requirements" sheet for additional information.