

One Dimensional Motion using an Incline Plane Activity

Purpose

A cart traveling down an inclined plane approximately represents a condition of constant acceleration. Using two photogates, an almost frictionless track, and a cart, you will determine the time it takes the cart to travel various distances, and you will plot position vs. time. Using the data that was collected and a particular kinematic equation, several equations can be generated. When pairs of these equations are solved simultaneously, the velocity (initial velocity) of the cart as it reaches the first photogate, and the acceleration of the cart can be determined. After you have determined the initial velocity and the acceleration of your cart, your TA will determine a time that you must match by properly positioning your photogates.

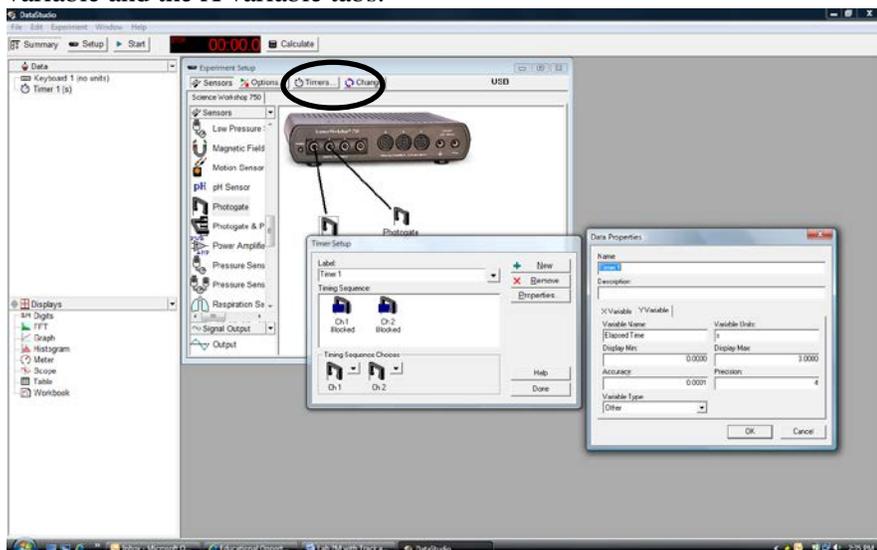
Pre Lab (10 pts)

Part I (40pts total)

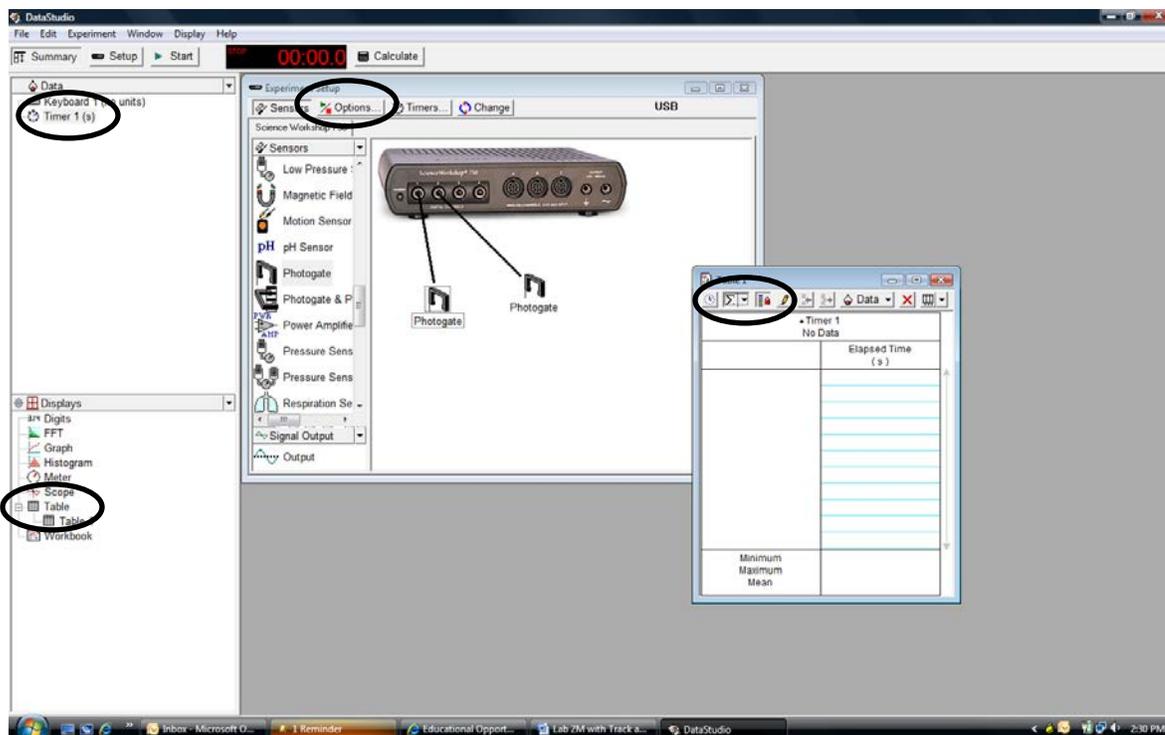
A photogate is a device that uses a beam of light and a detector to act as a switch. When the beam of light is broken, the detector can send a signal to a controller that could activate a multitude of devices. In this case, we will use two photogates to start and stop a timer.

Physically connect the photogates to the PASCO interface, and make sure the interface is turned on. Since the cart is too wide to fit through the photogates, an item referred to as a five pattern picket fence (PF) will be installed on the cart. The PF is a flat piece of plastic with various dark patterns. The dark patterns can be used to block the photogate's beam. Select which pattern you would like to use (it is recommended to use one of the rows with a solid pattern), and set the height of the photogates correspondingly. Each photogate has a red LED that should come on when the photogate is blocked.

Open Data Studio on the computer, and select Create Experiment. Select two photogates in the Data Studio software by dragging a photogate icon to the virtual interface box one at a time. Click the **Timers** button and set-up a timer. The timer should start when Photogate #1 is blocked, and the timer should stop when Photogate #2 is blocked. While in the Timer setup window, press the **Properties...** button and make sure the Precision (decimal places) is set to 4 in the Y variable and the X variable tabs.



In order to monitor the timer, a table will need to be created. Drag the table icon to the timer that you just created. Since it would be more accurate to average several times over each distance, it would be prudent to set some Start/Stop options and to apply some statistics. In the table window, press the button with the sigma symbol, and the max, min, and mean will be added to your table.



Now, click the *Options* button located in the virtual interface box window. Under the *Manual Sampling* tab, make sure that only the *Keep data value when commanded* box is checked; if the other boxes are checked, un-check them. When the appropriate boxes are checked, press the *OK* button. Now when the *Start* button is pressed, you will have an option to keep data by pressing the *Keep* button or to stop collecting data by pressing the button with the red square. However, if you press the button with the red square prior to pressing the *Keep* button, the last data point will be lost. If you do not wish to keep the last data point collected, just rerun the trial without clicking a button, and the data point will be automatically replaced with the new data point. When you are done collecting times for a particular distance, press the button with the red square and the trial for that particular distance will be complete. After the photogates are re-positioned for a new distance, press the start button, and data points will be collected in a new column within your table. Deleting the last run collected can be accomplished by going to the *Experiment* menu located on the main window.

Now using the metric scale fixed to the track and the photogates, you can determine the length of time it takes for the cart to travel various distances down the inclined track. Using this data, determine the acceleration and initial velocity as appropriate.

Part II (50pts total)

After you have determined your acceleration and the initial velocity, your TA will remove your cart from your station and provide you with a time. Your goal is to position the two photogates such that the time it takes the cart to travel between the two photogates is equal to the time given by your TA. You are free to position the photogates to any location that you desire. When you are ready, your TA will return your cart and witness the times. The average of three trials will be your time, and your grade will be based on percent error.

Name: _____

Banner ID: _____

Lab Group ID: _____

Number of Lab Partners: _____

Data Sheet

Lab 2M with Track and Photogates

Hints:

1. Be mindful of which photogate is plugged into which port.
2. The first photogate should be positioned such that it is not blocked before the cart is released. It is recommended to allow the cart to move at least 5cm before the first photogate is blocked.
3. Since the timer does not begin until the first photogate is blocked, it would be beneficial to correspond the position of the first photogate as the initial position with a value of zero. Therefore when the cart reaches the initial position, the cart will have an initial velocity that is *not zero*.
4. It is critical to start the cart from rest and from the same point on the track for each trial. Pull the back of the cart against the stop located at the top of the incline and release the cart without giving it a push.
5. Be aware that the adjustable backstop and one end of the cart have magnets.
6. The cart has mounting grooves such that the picket fence can be mounted in an upright position.
7. Use MS Excel to plot and fit your data.

Pre Lab (10 pts) _____

Part I (40pts total)

Print and attach the table of times (Hand write the distances that correspond to the times on the table).

Attach the plot of position vs time (10 points)

Acceleration: _____ (15 points)

Initial Velocity: _____ (15 points)

Attach all data, calculations, and plots.

Part II (50pts total)

Cart # _____

Time Given by TA (A): _____

Actual Times Witnessed by TA _____

Average of Actual Times (B): _____

$$\text{Percent Difference} = \frac{|A - B|}{A} \times 100\% = \underline{\hspace{2cm}}$$

Percent Difference	<=0.5%	<=1%	<=2%	<=3%	<=4%	>4%
Points	50	45	40	25	10	0