Lab M05: *Measuring Acceleration on an Incline with a Picket Fence*

10/20/03

Goals: To learn and practice the picket fence method of measuring acceleration and to use the method to measure acceleration of a glider on an airtrack tilted at various angles.

Introduction: The most common method used to gather acceleration data is to generate a velocity-vs-time graph and then find the slope. The picket fence method as used in this lab does just that. A Plexiglas strip is divided into alternating dark and clear strips of equal width. When the strip moves through a photogate interfaced to a computer, time intervals are measured for the passage of successive dark strips through the gate. The raw data are then converted to a graph of velocity vs. time. Using the analysis portion of the software, the slope of the v-t graph is then determined.

You will perform several trials with a glider freely moving on the air track. For each trial, the computer will produce a velocity-vs.-time graph and perform a linear regression to the data. You will use the graph to determine the initial velocity of the glider as the photogate was first blocked and the acceleration of the glider as it passed through the gate.

Besides learning the picket fence method, you will vary the tilt of the airtrack to explore how the acceleration depends on the tilt.

Method/Instructions:

The following steps are done only once:

A) To begin, make sure your glider and photogate are ready. Lay a picket fence along the groove on the top of a red or blue glider and secure it with a strip of tape at the bottom on both sides. With the glider on the air track, position the photogate so that the picket fence can pass unobstructed through the gate.
B) Be sure that the photogate beam is perpendicular to the plane of the fence.
C) Check the photogate is plugged into the DIG/SONIC1 port of the gray-green Lab Pro interface box.
D) Open the software by selecting Start, Programs, Vernier Software, Logger Pro 3.1 (or by double-clicking on the Logger Pro 3.1 desktop icon)
E) Go to File and choose Open, Experiment Folder, Probes & Sensors, Photogates, Motion Timer – Picket Fence.
F) Right click on the displayed data table and delete.
G) Right-click on the triple graphs, and delete them. Go to Insert, Graphs and create a new Velocity-vs.-Time Graph (left click on the graph's vertical label to select the variable to be plotted). Double click on the new graph, unselect Connect Lines and select Point Protectors. Enlarge the graph so it fills most of the screen.
H) Turn on the air supply.

The following steps are done in each trial
after you've *discussed your prediction* with your partner

I) Set the desired tilt of the track by placing the correct height riser blocks under the single leg of the track. There are four height riser blocks that provided. The height of these blocks will be measured in 'arbitrary height units' where the block thicknesses are 1 ahu, 2 ahu, 4 ahu and 8 ahu. Use these according to instructions from your teacher. The maximum you should use for any trial is 8 ahu!
J) Click on Collect Data.
K) Wait until you see two lights (one yellow, one green) flash on the LabPro interface; after they flash, no more lights should be lit on the LabPro; also, the Table Window on the computer screen should now be blank

Except for the case of the flat airtrack which will require an initial push of the glider, you should simply release the picket fence glider so it freely goes down the incline through the photogate as demonstrated in class. Always stop the glider & picket fence before it hits the end of the air track (but only after it has finished passing through the photogate.)

L) The glider's velocities should now appear on your graph, though you may have to hit the autoscale button to view the velocities. If they do not appear, reset the LabPro interface by disconnecting its power supply, then reconnecting it. Wait until three lights (red, yellow, green) flash on the LabPro box before returning to step J above.

M) From the v-t graph, VISUALLY assess whether the acceleration was approximately constant while the picket fence was moving through the photogate. If not, retake your data. If so, continue.

N) Click and drag to select <u>all</u> data points on the v-t graph (IMPORTANT!). Then click on the "R=" button to get a linear regression fit to the velocity-vs.-time data. (Why linear?).

O) Along with the linear fit values, the computer will show you a correlation coefficient R which is a measure of the probability that the data are actually correlated in a linear relationship. A value of 0 means no correlation; 1 (or -1) means perfect correlation. You should obtain a near-perfect correlation for every experiment (except possibly the one for the flat airtrack). If you obtain an R value that is not very nearly 1.000 (or -1.000) for any trial with the airtrack tilted, there was probably a problem with your data collection, and you should retake your data.

P) Once you are satisfied that the trial is valid, record the linear fit values (slope M and velocity-intercept B) in the appropriate places in the data table.

PRELAB #1) Consider the air track to be perfectly horizontal (untilted) for this part. Imagine you give the glider a push to send it through the gate. However, you make sure to stop pushing before any portion of the fence enters the gate.

Sketch the shape of the Velocity-vs.-time graph for the glider as it passes freely through the gate:

Explain the slope of the velocity-vs.-time graph. What is it? In terms of net force and perhaps momentum, why should it have that value?

PRELAB #2) Now assume one end of the air track is lifted with riser blocks, i.e., it is now an incline. Assume the glider is released (NOT pushed) at a point slightly higher on the air track than the photogate.

Sketch the shape of the Velocity-vs.-time graph for the glider as it freely passes through the gate:

Explain the slope of the velocity-vs.-time graph. Why is it not the same as in PRELAB #1? Be sure to explain in terms of net force and perhaps momentum.

Report for lab M05

Name_____ blk _____
Partner(s) _____

Raw Data:

Mass of glider including picket fence = _____ kg

Total height of riser blocks used	Trial #	Acceleration—$\Delta v/\Delta t$ = slope of v-t graph (m/s^2)	Initial velocity—y intercept of v-t graph (m/s)
0 ahu (no blocks)	1		
	2		
	3		
8 ahu	1		
	2		
	3		
7 ahu	1		
	2		
	3		
6 ahu	1		
	2		
	3		
5 ahu	1		
	2		
	3		
4 ahu	1		
	2		
	3		
3 ahu	1		
	2		
	3		
2 ahu	1		
	2		
	3		
1 ahu	1		
	2		
	3		

Analysis:

1. Create a graph with acceleration on the y-axis and total height of riser blocks on the x axis. Use either your calculator or the Graphical Analysis software on a computer.

2. What is the shape of the graph from visual inspection? Fit the graph with the appropriate regression.

3. Carefully sketch the fitted graph below.

4. Record the equation of fit for the graph, including the units.

5. In full sentences, explain the actual meaning of your graph.

6. What would be the “ultimate incline”, i.e., the airtrack orientation for maximum possible tilt for the airtrack? What acceleration would you expect in this case? Why?