Name:_____ Date:_____
Dr. Croom's Physics Lab 02-9

Picket Fence Free Fall [FORMAL LAB]

We say an object is in *free fall* when the only force acting on it is the earth's gravitational force. No other forces can be acting; in particular, air resistance must be either absent or so small as to be ignored. When the object in free fall is near the surface of the earth, the gravitational force on it is nearly constant. As a result, an object in free fall accelerates downward at a constant rate. This acceleration is usually represented with the symbol *g*.

Physics students measure the acceleration due to gravity using a wide variety of timing methods. In this experiment, you will have the advantage of using a very precise timer connected to the computer and a Photogate. The Photogate has a beam of infrared light that travels from one side to the other. It can detect whenever this beam is blocked. You will drop a piece of clear plastic with evenly spaced black bars on it, called a Picket Fence. As the Picket Fence passes through the Photogate, the computer will measure the time from the leading edge of one bar blocking the beam until the leading edge of the next bar blocks the beam. This timing continues as all eight bars pass through the Photogate. From these measured times, the program will calculate the velocities and accelerations for this motion and graphs will be plotted.

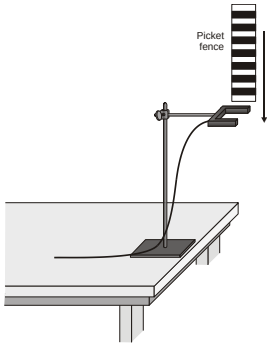

Figure 1

OBJECTIVE

- Measure the acceleration of a freely falling body (*g*) to better than 0.5% precision using a Picket Fence and a Photogate.

MATERIALS

Computer
Pasco Interface
Data Studios
Photogate
Picket Fence
clamp or ring stand to secure Photogate

PROCEDURE

1. Fasten the Photogate rigidly to a ring stand so the arms extend horizontally, as shown in Figure 1. The entire length of the Picket Fence must be able to fall freely through the Photogate. To avoid damaging the Picket Fence, make sure it has a soft surface (such as a carpet) to land on.
2. Connect the Photogate to Digital input on the Pasco Interface.
3. Open up data studios and make sure your interface box is connected.
4. Click on add instrument and choose photogate and picket fence. Close all windows.
5. Open a velcocity graph and an acceleration digits windows.
4. Block the Photogate with your hand; note that the Photogate is shown as blocked. Remove your hand and the display should change to unblocked.
5. Click start to prepare the Photogate. Hold the top of the Picket Fence and drop it through the Photogate, releasing it from your grasp completely before it enters the Photogate. Be careful when releasing the Picket Fence. It must not touch the sides of the Photogate as it falls and it needs to remain vertical. Click stop to end data collection.
6. Examine your graphs. The slope of a velocity *vs.* time graph is a measure of acceleration. If the velocity graph is approximately a straight line of constant slope, the acceleration is constant. If the acceleration of your Picket Fence appears constant, fit a straight line to your data. To do this, click on the velocity graph once to select it, then click auto fit to fit the line $y = mx + b$ to the data. Record the slope in the data table.
7. To establish the reliability of your slope measurement, repeat Steps 5 and 6 five more times. Do not use drops in which the Picket Fence hits or misses the Photogate. Record the slope values in the data table.

DATA TABLE

Trial	1	2	3	4	5	6
Slope (m/s^2)						

	Minimum	Maximum	Average
Acceleration (m/s^2)			

Acceleration due to gravity, $g \pm$ *a.d.*	$\pm$ m/s^2
Accuracy	%

CALCULATIONS

1. From your six trials, determine the minimum, maximum, and average values for the acceleration of the Picket Fence. Record them in the data table.

2. Cacluate the Average Deviation from the Mean and Average Deviation of the Mean.

Questions/Things you need to do individually:

1. Make an entry in your lab notebook with the title of this lab, the date, a note that you submitted this lab formally. Use this space to jot down any observations, measurements, or thoughts you make while performing the lab.
2. Write a formal lab using the rubric provided. ONLY include the sections that are on the rubric.
3. Write a theory that explains the acceleration due to gravity. Write it so freshman could pick up the lab report and be able to answer the following questions.
    - What is acceleration?
    - What is velocity?
    - What is the relationship between velocity and acceleration?
    - What is gravity?
    - Would any of the following change the acceleration of the picket fence? If you would like to experiment with any of these, feel free to come back to class to run the experiment during study or a lunch.
        - Dropping it from higher above the Photogate.
        - Throwing the Picket Fence downward through the photogate but letting go of it before it enters the Photogate
        - Throwing the Picket Fence upward?
    - How would adding air resistance change the results?
    - What would the shape of a velocity time graph of a falling object without air resistance look like?
    - What would the shape of a displacement *vs* time graph of a falling object without air resistance look like?

4. Make sure your analysis and your results sections are separate. Analysis tries to explain how much error is in the lab. The results section tells what the results are showing and answer the questions is the hypothesis supported? Is the purpose met?