Freely Falling Object

Equipment Needed

1 Picket Fence   OYS
1 Level   OYS
1 Universal Clamp   OYS
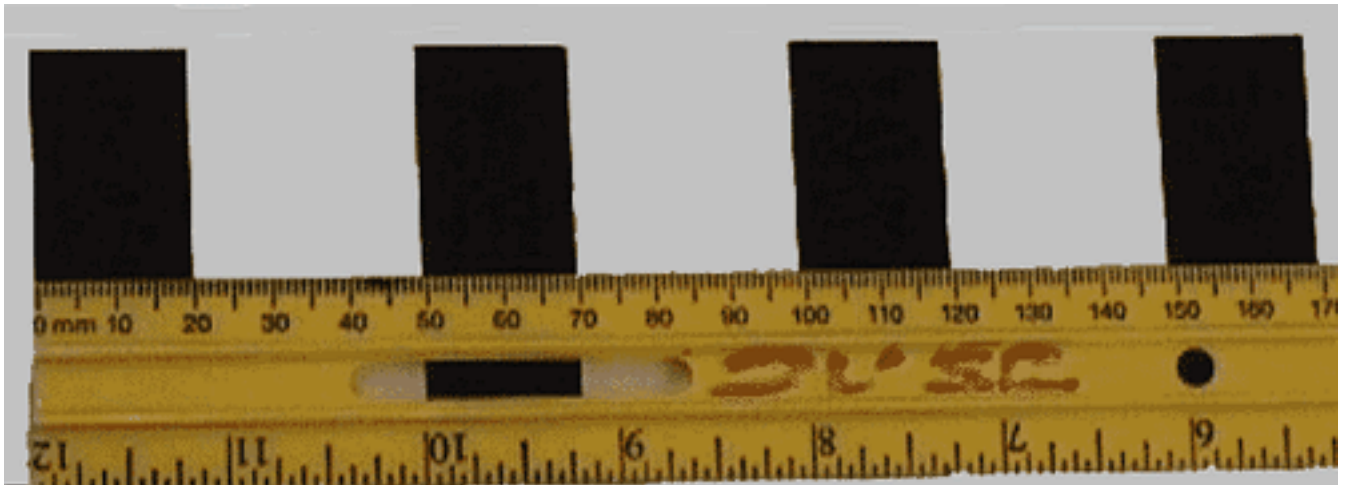1 Computer / Photogate attached
1 Catch Box

Figure 1: Picket Fence showing four pickets.

Purpose

The purpose of this lab is to verify: (a) the acceleration of gravity by timing the motion of a freely falling object and (b) the area under a velocity vs time graph equals the displacement.

Precaution

- When performing free-fall experiments, place a soft pad in the catch box and place under the experiment to cushion the fall of the picket fence.

- Level the photogate, and tighten securely.

- For accurate results, drop the picket fence though the Photogate vertically as shown in Figure 2.

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- To achieve vertical alignment of the picket fence, hold it between your thumb and forefinger centered at the top of the bar, before releasing (see Figure 2).

- If the picket fence hit the photo gate, or if you have less than six data points, you must redo the drop.

- Ensure box is positioned so that you can "catch" the picket fence before it impacts the floor!
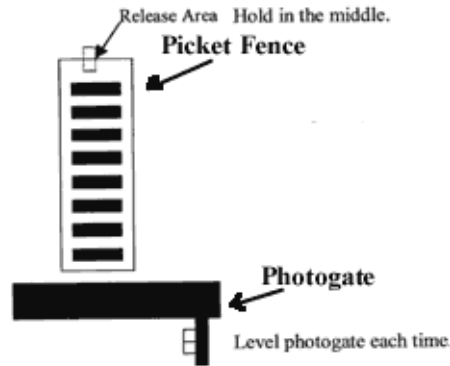

Figure 2: General Setup

Procedure

1. Using a $30cm$ ruler you will now take the picket fence and measure the distance between the leading edges of the pickets, as shown in Figure 1. Record the values for all the pickets in Table 1. The pickets are referred to by numbers 0 to 7 (a total of eight pickets), the leftmost one being "0", the next is "1", ...etc.

2. Set up the apparatus as in Figure 2.

3. Connect the photogate to digital channel 1 on the interface box.

4. Connect the PASCO interface box to the computer. Choose the program "Data Studio" on the computer. Click on "Create Experiment" after the program begins.

5. The `Experiment Setup` window automatically opens. Click on the image of channel 1. From the popup list scroll down and select `Photogate & Picket Fence` and click `OK`.

6. At the bottom of the `Experiment Setup` window, check the measurements of `Time`, `Count`, `Position`, `Velocity` and `Acceleration`.

7. On `Experiment Setup` window. Click on the `Sampling Option...` to open another popup window. Click on the tab `Delayed Start`, select `Data Measurement` and set it to `Count Of Bands Is Above 0.000 counts`.

8. Still in the `Sampling Option...` popup window, click on the tab `Automatic Stop`, select `Data Measurement` and set it to `Count Of Bands Is Above 6.000 counts`. Click `OK`.

9. Close the `Experiment Setup` window. Anytime you wish to make changes to the setup you can click on `Setup` on the to left hand corner of the main window.

10. Under `Display`, you see the item `Graph`. Double click on it and a `Data Source` window opens. Click on `Time` and select `OK`. A blank graph should open.

11. Under `Display`, triple click on `Graph 1` and change its name to "Time".

12. Repeat the last two steps to open the graphs for `Count`, `Position`, `Velocity` and `Acceleration`. Now you are ready for data collection.

13. Click on the `Play` button and position the picket fence slightly above the photogate. Make sure the picket fence is still and vertical and gentle let go. The computer automatically begins taking data the moment the first dark band passes the photogate.

14. Study the graphs and follow the analysis below.

Data and Analysis

Table 1: Measurements of the Picket Fence Using Ruler.

Picket Number	1	2	3	4	5	6	7
Distance* from the previous picket (*cm*)							

*: The distance should be measured from one leading edge to the next.

Velocity vs Time Graph

We will study the velocity vs time graph in this section. You can see Figure 3 for a sample. The graph could be divided into 6 intervals as shown. Complete Table 2 and 3 based on your graph.
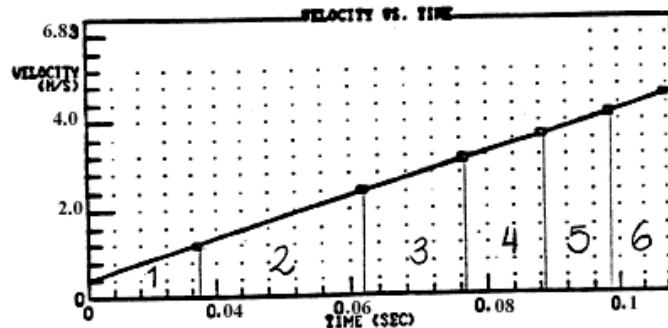

Figure 3: Sample Velocity vs Time Graph

Table 2: Calculating Displacement from Area under the Velocity vs Time Curve

Interval	1	2	3	4	5	6	7
Time at the beginning of each interval (s)							
Time at the end of each interval (s)							
Time between interval (s)							
Area under the curve (cm)							

Table 3: Calculating Acceleration from the Slope of the Velocity vs Time Curve

Interval	1	2	3	4	5	6	7
Slope of the curve (m/s^2)							
Average slope (m/s^2)							
Percentage difference with $g_{accepted}$							

Acceleration vs Time Graph

Use the acceleration vs time graph on the computer to compute the average acceleration due to gravity $g_{measured}$.

$g_{measured}$ = _____

Percentage difference with $g_{accepted}$ = _____

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