Disclaimer: This lab write-up is *not* to be copied, in whole or in part, unless a proper reference is made as to the source. (It is strongly recommended that you use this document *only* to generate ideas, or as a reference to explain complex physics necessary for completion of your work.) Copying of the contents of this web site and turning in the material as "original material" is *plagiarism* and will result in serious consequences as determined by your instructor. These consequences may include a failing grade for the particular lab write-up or a failing grade for the entire semester, at the discretion of your instructor.

Anything included in this report in RED (with the exception of the equations which are in black) was added by me (Bill) and represents the data I obtained when I ran the experiment. *Use your own data you collected and perform the calculations for your own data!*

For PES 1150 ONLY: You do NOT need to type your answers into the document, but can hand write the values and equations. Feel free to add more hard returns to areas to increase the space for answers or add drawing and pictures if they enhance the responses you provide. You may use any pictures I provide, as long as the proper reference is made (in accordance with the regulations against plagiarism as specified by the University).

NOTE: Sometimes the notes you take in class can be a little "garbled". If you use a sheet similar to this one in class to take your notes and record your measurements, it is sometimes "better" if you re-write your notes into a more legible form to be turned in. If you took good lab notes, then this process should be fairly trivial. Remember that neatness will get you far. If something is hard to read or follow, it is more likely to be counted off!

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Title: Motion in one dimension Name ___

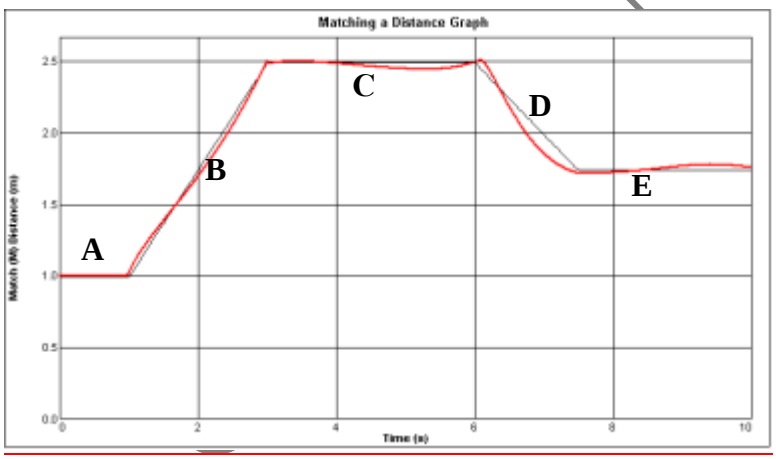
Objective

The goals of this lab are: 1) to understand the relationships between distance, velocity and acceleration, 2) to be able to interpret graphs of distance, velocity and acceleration vs. time, 3) to analyze the motion of a student walking across the room and 4) to measure a value of "g", the acceleration of gravity. (Argh! I couldn't help it. I had to fix the incomplete sentences! Nothing drives me up the wall more than sentence fragments and improper grammar!)

Data and Calculations

Part A: Match position vs. time graph

- Sketch your result in the box below.



- Comment on each part of the graph and what you had to do to get that data to match.

A: First Flat Plateau - Binder was held in a single position at 1.0 meters away from the sensor. [0 sec ≤ t ≤ 1 sec]

B: Increasing; Positive Slope - Binder was moved away from the sensor at a constant speed. [1 sec ≤ t ≤ 3 sec]

C: Second Flat Plateau - Binder was held in a single position at 2.5 meters away from the sensor. (Notice there are some minor hick-ups in the match due to natural human reflexes/delay of staggering and balance variation of the binder.) [3 sec ≤ t ≤ 6 sec]

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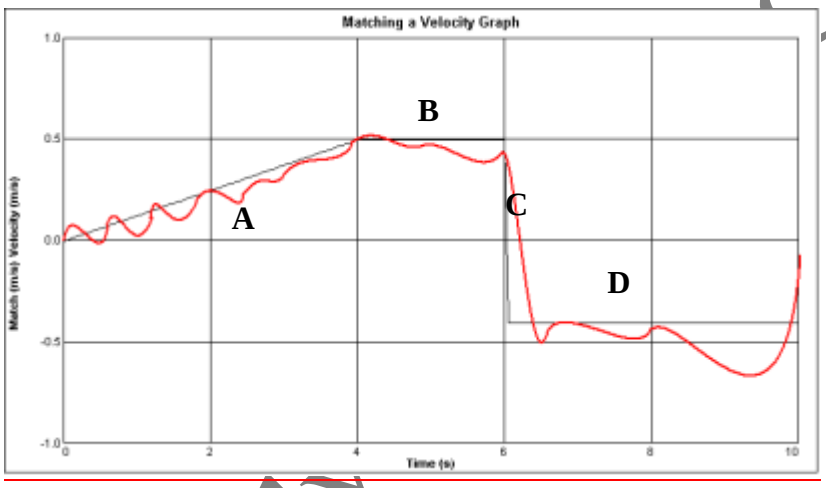
D: Decreasing; Negative Slope - Binder was moved toward the sensor at a constant speed. [6 sec ≤ t ≤ 7.5 sec]

E: Third Flat Plateau - Binder was held in a single position at 1.0 meters away from the sensor. [7.5 sec ≤ t ≤ 10 sec]

Part B: Match velocity vs. time graph

- Sketch your result in the box below.



- Comment on each part of the graph and what you had to do to get that data.

A: Increasing; Positive Slope – Started not moving and slowly moved away from the sensor. Picked up speed the further away we got. ("Positive acceleration".) [0 sec ≤ t ≤ 4 sec]

B: First Flat Plateau – Maintained the speed away from the sensor. (Zero acceleration.) [4 sec ≤ t ≤ 6 sec]

C: Sharp Drop – Instantaneously stopped moving and starting moving toward the sensor. (Instant "negative accelereation" – or "deceleration") [6 sec ≤ t ≤ 6.1 sec]

D: Second Flat Plateau - Maintained the speed toward the sensor. (Zero acceleration.) [6.1 sec ≤ t ≤ 10 sec]

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Part C: One Dimensional Kinematics

- Fill in the following table

Drop	Value for "g"
1	9.7468 m/s^2
2	9.7547 m/s^2
3	9.7785 m/s^2
average	9.76 m/s^2

The average is calculated using the following equation:

$$\langle x \rangle = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Where x is the data we are finding the average of, and x_i are the individual components of the given data. Furthermore, N is the total number of elements in the given data. For our case, N is 3, and x is acceleration due to gravity, found during the experiment; hence:

$$\langle g_{Measured} \rangle = \frac{1}{3}\sum_{i=1}^{3} g_i$$

$$\langle g_{Meaasured} \rangle = \frac{1}{3}\left(9.7468\frac{m}{s^2} + 9.7547\frac{m}{s^2} + 9.7785\frac{m}{s^2}\right)$$

$$\boxed{\langle g_{Measured} \rangle = 9.760\frac{m}{s^2}}$$

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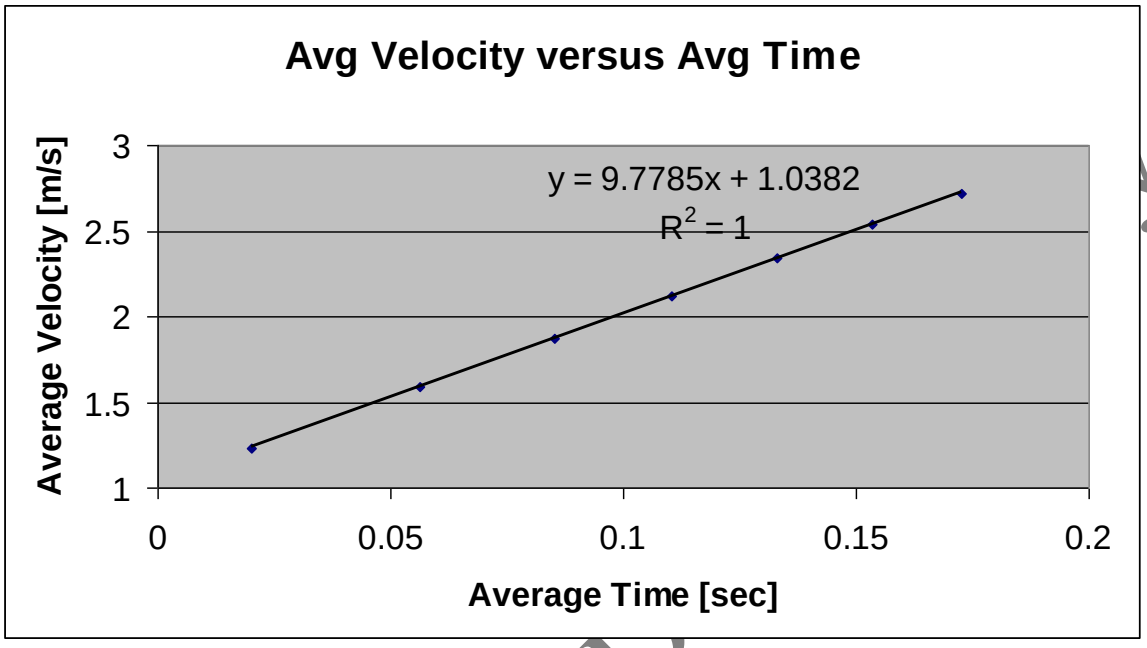
- Sketch the graph of the final drop.

You might need to change the values along the axis. I just made a guess at the values.



I used the "Cut and Paste" technique to get this graph from Logger Pro© to Microsoft Word. This will work on a graph containing data as well. The procedure is quite simple, highlight the graph you wish to copy in Logger Pro by clicking on it and select "Copy" from the "Edit" menu. Open Word and select the location and use the "Paste" command. That's it! You can find a copy of the Logger Pro software on the *Physics lab webpage.* Just remember to save your logger pro file. Word is also available on the lab computers if you wish to save the graph in word format.

Results and Questions

Part A and B

- What type of motion is occurring when the slope of a distance vs. time graph is zero?

The type of motion occurring when the slope of a distance vs. time graph is zero is the object being measured was held at a single position away from the sensor. The object had

a velocity (speed) of 0 m/s during that duration of time. These can be seen as plateaus in the data collected above (see descriptions for A, C and E in Part A).

- What type of motion is occurring when the slope of a distance vs. time graph is constant?

The type of motion occurring when the slope of a distance vs. time graph is constant is, like above, the object being measured was held at a single position away from the sensor. The object had a velocity (speed) of 0 m/s during that duration of time. These also can be seen as plateaus in the data collected above (see descriptions for C and E in Part A).

- What type of motion is occurring when the slope of a distance vs. time graph is changing?

The type of motion occurring when the slope of a distance vs. time graph is changing is the object being moved at a constant rate of distance over time. The object had a positive or negative velocity (speed) during that duration of time, depending on the direction be traveled (toward/away). These can be seen as incline and decline in the data collected above (see descriptions for B and D in Part A).

- What type of motion is occurring when the slope of a velocity vs. time graph is zero?

The type of motion occurring when the slope of a velocity vs. time graph is zero is the object being measured was moved with a constant velocity away from/toward the sensor. The object had acceleration (speed increase) of 0 m/s^2 during that duration of time. These can be seen as plateaus in the data collected above (see descriptions for B and D in Part B).

- What type of motion is occurring when the slope of a velocity vs. time graph is not zero?

The type of motion occurring when the slope of a velocity vs. time graph is not zero is the object being measured was moved with an increasing/decreasing velocity away from/toward the sensor. That is to say, the object was speeding up or slowing down. The object had a positive/negative constant acceleration (speed increase) during that duration

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of time. These can be seen as incline and decline in the data collected above (see descriptions for A and C in Part B).

Part C

- Compare the average value of "g" to the accepted value of, $9.81\ {}^{m}/_{s^2}$.

We will take the standard accepted value of the acceleration due to gravity at sea-level and at the equator to be the theoretical value for g. Likewise, we will take the measured value to be the average calculated in the question above. Hence:

$$g_{Theory} = 9.81\frac{m}{s^2} \qquad g_{Measured} = 9.76\frac{m}{s^2}$$

Using the percent difference, we can compare the "measured" acceleration due to gravity with the "theoretical" acceleration due to gravity.

$$\%\ difference = \frac{|g_{Theory}| - |g_{Measured}|}{|g_{Theory}|} x100\% = \frac{\left(9.81\frac{m}{s^2}\right) - \left(9.76\ \frac{m}{s^2}\right)}{\left(9.81\ \frac{m}{s^2}\right)} x100\%$$

$$\boxed{\%\ difference = 0.5097\%}$$

- Explain possible reasons your value might differ from this accepted value.

As discussed during the lecture in class, there are several possible reasons why we came up with an erroneous measurement of the acceleration due to gravity. Several of these are listed below:

1. Altitude of Colorado Springs (due to the curvature of the Earth)
2. Direction of the gravity vector is not exactly nadir/zenith pointing (and slightly out of plane)
3. Tilt on the dropped picket fence (pseudo-length increase of measured distances and simple harmonic motion)
4. Human error
5. Instrument limitations
6. Other (You are intelligent scientists, so see if you can come up with other possible explanations of potential error sources in the experiment.)

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Conclusion

- This closing paragraph is where it is appropriate to conclude and express your opinions about the results of the experiment and all its parts. Only the final result(s) needs to be restated. This part is up to you this time, see the "Write up Guidelines" link on the web page for further help.

<You should have something here for your conclusion. Were the objectives met? Were there any difficulties associated with the lab? Was the Velocity vs. Time graph matching exercise hard? What made it so difficult? Etc…>

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