Acceleration Due to Gravity

In this lab, you will examine the acceleration due to gravity. Remember that acceleration is the rate of change of an object’s velocity. Also, remember that both velocity and acceleration are vectors, so they both have magnitude and direction. As a result, the object’s velocity can change, or it can accelerate, if the object speeds up, slows down, or changes direction. For example, an object can be traveling at a constant speed but still be accelerating if its direction of motion is changing. Typically, the slowing down of an object is called deceleration, but it can also be represented by a negative acceleration.

Procedure

1. Extend the paper tape until it touches the floor, with approximately one or two feet of slack.
2. Tear the tape, and write the names of your group members on it.
3. Attach the weight to the end of the tape. The best way to do this is to run one end of the tape through the nut and secure the tape to itself.
4. Mark your tape to indicate to which end the weight was attached.
5. Place the carbon disk on the dot timer. It may already be in place, but check here.
6. Feed the end of the tape without the weight through the dot timer until the weight is within one foot of the timer. Do your best to keep the tape stretched out; it will take several group members to do this. The best way is to use your hands to support the tape, instead of holding it.
7. Place the timer at the edge of the wall, holding the weight in one hand and the timer with the other. Be sure to place it close enough to the edge so that the weight does not contact the wall during its descent.
8. Start the dot timer.
9. Drop the weight.
10. Retrieve the tape, make sure there are visible dots on the tape, remove the weight, and return to the classroom.

11. Choose a dot between one and two feet from the weighted end of the tape. Hint: Try to choose a dot that begins a sequence of dots that have increasing distance between them.

12. Mark your starting dot as one, and then number the next ten.

13. Measure the distance, in meters, from the first dot to each of the others. Record the distances in Table 1.

14. Proceed with the calculations as outlined in Table 1.

15. Generate three plots, displacement as a function of time, velocity as a function of time, and acceleration as a function of time.

### Table 1: Data Table for Acceleration Calculation

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Displacement (m)</th>
<th>Velocity (m/s)</th>
<th>t = tn+1 - tn</th>
<th>Acceleration (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>t₁ = 0.017</td>
<td>x₁ =</td>
<td>v₁ = (x₂-x₁)/t =</td>
<td>a₁ = (v₂-v₁)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₂ = 0.033</td>
<td>x₂ =</td>
<td>v₂ = (x₃-x₂)/t =</td>
<td>a₂ = (v₃-v₂)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₃ = 0.050</td>
<td>x₃ =</td>
<td>v₃ = (x₄-x₃)/t =</td>
<td>a₃ = (v₄-v₃)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₄ = 0.067</td>
<td>x₄ =</td>
<td>v₄ = (x₅-x₄)/t =</td>
<td>a₄ = (v₅-v₄)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₅ = 0.083</td>
<td>x₅ =</td>
<td>v₅ = (x₆-x₅)/t =</td>
<td>a₅ = (v₆-v₅)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₆ = 0.100</td>
<td>x₆ =</td>
<td>v₆ = (x₇-x₆)/t =</td>
<td>a₆ = (v₇-v₆)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₇ = 0.117</td>
<td>x₇ =</td>
<td>v₇ = (x₈-x₇)/t =</td>
<td>a₇ = (v₈-v₇)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₈ = 0.133</td>
<td>x₈ =</td>
<td>v₈ = (x₉-x₈)/t =</td>
<td>a₈ = (v₉-v₈)/2t =</td>
<td></td>
</tr>
<tr>
<td>t₉ = 0.150</td>
<td>x₉ =</td>
<td>v₉ = (x₁₀-x₉)/t =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t₁₀ = 0.167</td>
<td>x₁₀ =</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Report**

The report for this lab should not only present the data and corresponding plots from the experiment, but should also provide some analysis of the data. This analysis should include discussion of the shape of the graphs for position, velocity, and acceleration as functions of time, and what the shape of the graph indicates about the motion of the object. Your book will prove to be a valuable aid in the development of this discussion.
Report Outline

Title Page

Abstract
This should summarize the results and discussion that are presented in your report, and be included, at the beginning, on a separate page.

Introduction
This section should introduce (hence the name) the theory behind the experiments. It should be written so that, after reading this section, someone with little or no knowledge of the experiment can gain at least a basic understanding of it. In this section, you should also include the hypothesis for the experiment and an outline for the rest of your report. This section should conclude with a sentence of the form:

In the following sections, …

Here the … should include an outline of the sections of your report. This sentence provides the reader with a roadmap of your report.

Experiment Setup and Procedure
This section describes the experimental setup and procedure. IT DOES NOT PRESENT THE RESULTS FROM IT.

Results and Discussion
This is the section where you present the results from your experiment. The results should be presented using charts and figures, as applicable. Be sure to follow the guidelines in the class template when using these items. Also, be sure to choose the type of graph that best conveys the main theme of your data. This will be the section in which the analysis of the experimental data occurs. This would include discussion of possible experimental errors, incorrect assumptions, and/or effects that were not considered.

Conclusion
Very briefly summarizes the results and discussion presented in the report. This is very similar to the abstract. Contrary to the name, no new information or conclusions are presented in this section.
Report Guidelines

Proper report formatting is important to the overall success of your report. It allows the reader to concentrate on the information that you are presenting. A reader can easily become distracted by improper and/or inconsistent formatting, causing your ideas to get lost. In addition, a well formatted paper helps to “sell” that it is good work.

A template with correct page format can be found on the class website. If you need help changing these settings, please ask for it. “I didn’t know how to change the settings” is not an acceptable excuse for incorrect formatting.

Tutorials on how to insert equations, figures, and graphs can also be found on the class website. If you need help, please ask for it. “I didn’t know how to insert an equation, figure, or graph” is not an excuse for not having them, or doing them by hand. The report template also includes the proper way to insert and discuss figures, tables, and equations.

1. One report per group will be collected.
2. MAXIMUM page length, not including the title page, abstract, figures, and graphs, is 2 pages.
3. Spelling and grammar should be correct.
4. The report must be computer generated, including figures, graphs, and equations.
5. Text should be 12-point font, Times or Times New Roman, 1.5 line spacing, justified.
6. Page margins should be 1 inch all the way around.
7. Figures and should be numbered and have descriptive captions.
8. Equations should be numbered.
9. When talking about a figure or graph refer to it by number. For example, blah blah blah is shown in Figure 1. Or, Figure 2 is a plot of blah blah blah. (Replace the blah blah blah with the actual description of the figure or graph)
10. Clearly indicate sections. Use bold type for the heading. You should space one line between the previous paragraph and the section heading. (See the section breaks in this document). Subsections can be indicated by a similar space and italic type.