Formal Lab Report Due Date: _NLT 1/23/15_____

# Acceleration Due to Gravity

This is a verification experiment to determine the acceleration due to gravity and the properties of kinematic graphs. In your report, explain what the theoretical value of the acceleration due to gravity is and what you are going to verify for the kinematic graphs.

**Procedure**

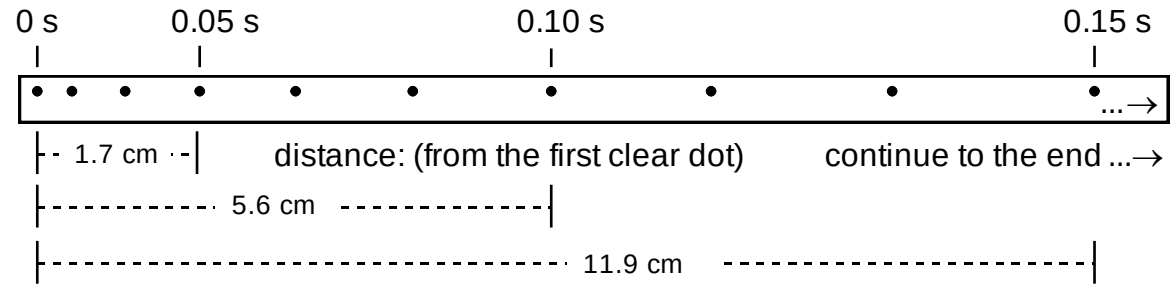
Mount the recording timer vertically. You should have enough tape so that it reaches the floor. Attach the mass to the tape, be sure the tape won't get stuck on anything as it is going down since it needs to be *free-falling*. Hold the tape, turn on the spark timer, then release the tape. Make sure that the mass strikes a board on the floor, not the floor or your feet. The paper tape should pull free of the timer just before the mass strikes the board. Inspect the tape to be sure there are dots and that they increase in distance the further away from the start. Each student should run their own tape, using a different mass than their partner(s). Be sure to record in your **report the mass** that you used. {The best findings are for those heavier masses that easily overcome the force of friction from the tape dragging through the timer.}

After you have your tape, place it on a tabletop with the carbon dots facing up. Mark across the tape through the first dot from the initial "smudge" and label that line "0". Now mark across the tape through every third dot. Since the timer makes 60 dots per second, every third dot represents 3/60 of a second, or 0.05 s. Measure the distance to each successive pencil mark on the paper from the "0" mark. Record these distances in meters right on the paper tape. After you have your measured all of your data, **cut** the first 10" of paper tape and **tape** it onto your lab report **near** your **data table**.

**Sample Data Table**

| *Mass:* _____ *g* = _____ *kg* | | | |
|---|---|---|---|
| $t$(s) measured by timer | $x$(m) measured from 0 | $\Delta x$ (m) calculated | $v$ (m/s) calculated |
| 0.00 | 0.000 | | |
| 0.05 | 0.017 | 0.017 | 0.34 |
| 0.10 | 0.056 | 0.039 | 0.78 |
| 0.15 | 0.119 | 0.063 | 1.26 |
| etc. | etc. | etc. | etc. |

**Sample Data:** time: (dots are 1/60 s apart, 3/60 s = 0.05 s)

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The change in position ($\Delta x$) is the difference between successive values of $x$, or the distance between successive pencil marks on your paper tape. Divide this change in position by the change in time (which will always be 0.05 s) to give the average velocity ($v$) for the time interval.

This velocity is most applicable at the middle of the time interval; it is both recorded on the data table and plotted on the velocity graph between the two times that produced it.

Use Google Sheets or Excel to make two graphs from this data, a *position vs. time* and a *velocity vs. time* graph. The $\Delta x$ data is only used to calculate the velocity ($v$).

The position graph should show increasing velocity so should be curved. The velocity graph should show constant acceleration, which means a constant slope (a straight line). Have the software produce a trendline that will be the best-fit line through the points. Be sure the graph shows the trendline and the equation. Do not connect points.

Be sure to label the graphs properly and include your name. Print the graphs full-sized to answer the questions below.

Class data: You will be shared a Google sheet. Enter your information in a timely manner.

**Questions to address in your Analysis**

1. Draw a tangent line to the distance graph at t = 0.25 s. Calculate the slope of this tangent and compare it with the velocity at t = 0.25 s found from the velocity graph.
   Find the % difference between the two values.

2. Calculate the total area under the velocity graph from time zero to the final time on your data table. Compare this value with the final distance from the distance graph or the data table.
   Find the % difference between the two values.

3. Use the slope of the velocity graph. Compare this value to the accepted value for the acceleration of gravity: 9.80 $m/s^2$. Find the % error between these two values.

The % difference on questions 1 & 2 will give you some idea how accurate your lab was. The % error on question 3 will tell you how great an effect friction had on your experiment. The uncertainty for this experiment is ±10%, as it will be for most labs this year. Your experiment was a success if the absolute value of the % error (or % difference) is less than the 10% uncertainty for two out of the three questions. If you are beyond the values you may consider checking the calculations and/or retaking the data.

% difference = |difference of values| ÷ (average value) × 100%

% error = (accepted value - measured value) ÷ (accepted value) × 100%

4. How did your results compare to the class data? Use Quartile information in your explanation.

***Follow proper Formal Lab Report Guidelines for this lab.***