Measuring "g" using a Spark Timer DAL 12/4/13 **Name ______________________________ Block ___**

Purpose: Measure the acceleration of gravity as accurately as possible, using a spark timer.

Pre-Lab Activities

1. Read through the entire lab document and put a question mark next to any step that you find confusing. Highlight or underline steps in which you must record data so that they will be easy to find when you do the lab.

2. What is the accepted value of the gravitational constant **g** that we will be measuring today? g = ____

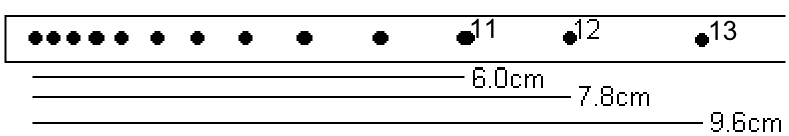
3. The spark timer will make a mark on a piece of paper every 1/60th of a second. If the distance between two successive points is 0.25m, the average velocity between those points is:
   $v = \Delta x / \Delta t = 0.025\text{m}/(1/60)\text{s} = 1.5\text{m/s}$.
   a. If the distance between two points is 3.6 cm, the average velocity between those points is __________.

4. Describe in words how you will use the spark timer tape shown below to measure the velocity near the point labeled 12. Then, use the measurements on the tape to calculate the velocity.

   a. What is the average speed between 11 and 12?

   b. What is the average speed between 12 and 13?

   c. What is the instantaneous speed at point 12?



5. One source of error in this experiment is friction between the tape and the timer. Do you expect that friction will result in larger or smaller measured value of **g**? Support your answer.

6. You will drop the mass with an initial velocity of zero. (Remember, $d = \frac{1}{2}at^2$)
   a. If the total fall is measured to be 0.65m, what should be the total time for the fall?
   b. How many points will the spark timer make in this amount of time?

Procedure

1. You will need to do a short, but formal, lab report, writing a clear numbered procedure.
2. Set up a spark timer, a 40-50 cm strip of spark paper, and a 50-200 gram mass to allow the timer to record the motion of the mass as it falls. Set up the lab to reduce the effects of friction as much as possible.
3. Please set up the lab so as to minimize the possible damage to masses, timers, floors, and feet.
4. Use the 60 Hz setting on the timer to produce a large amount of useful data.

Data and Calculations:

1. Find the starting position, dot zero, which is the first clear dot in the string of recorded dots. (Why is there a large blot of dots at the beginning?
2. Hold a ruler over the tape so the zero on the ruler is at dot zero. Measure the position of every subsequent dot. You may use a ruler marked in centimeters, you will have to convert to meters later. Keep in mind that these are at t = 1/60 s, 2/60 s, etc. (why is it more precise to measure the position of every dot rather than the displacement between each dot?)
3. Enter the data (dot number and position) into a spreadsheet, such as Excel. Start dot number from 0, and set the spreadsheet to add the proper increment to each subsequent row. If there is a missing data point on your strip, be sure to delete that time from your spreadsheet, and note the missing point in your lab report.
4. Make a column for time in seconds. Time = dot#/60.
5. Make a column for velocity, and enter the formula to calculate it. Remember that velocity = change in position from last dot / change in time from last dot. Format cells so numbers round to three decimal places.
6. Graph the velocity vs. time, and add a linear trendline, selecting the option to display equation. You may need to delete the first point if it does not line up with the others. This is a glitch caused by not knowing the actual position of the first dot in the big blob of dots.
7. The slope of the velocity time graph equals acceleration. Put the correct variables in the equation, instead of “y” and “x”. Rearrange the formula on the graph so it matches $v_f = v_i + at$.

Bonus/Challenge/More Advanced:

8. Graph the position vs. time, and add a quadratic trendline. (polynomial order 2) Adjust all labels to match actual measurements.
9. If you change the y and x to their proper variables, then you should recognize that the equation looks similar to one of the main kinematics equations. The coefficients in the trendline equation stands for actual values like acceleration and velocity. From the trendline, determine the acceleration of gravity.

Conclusion:

1. Give the final results of your experiment. State your measured value for “g”, the acceleration of gravity, and give the percent difference between your value and the accepted value.
2. Why do we use the value of the slope of the velocity vs time graph as a measure of the acceleration due to gravity?
3. How well was the velocity graph described by a linear fit? Were there discrepancies near the start or the end of the data sets? Were there any outliers?

Summary:

- Explain in normal words how you measured g.
- Explain what the units of acceleration mean.
- Explain what the coefficients in the trendline formula represent in real terms.
- List some possible sources of error. Note that “human error” is not a useful hypothesis, and that the U.S. electrical system operates at a very steady 60 Hz. Think about what actually caused a difference in acceleration, and how to minimize that source of error.