PHYS 1401
General Physics I

EXPERIMENT 2
MEASUREMENT OF THE ACCELERATION OF GRAVITY

I. OBJECTIVE

The objective of this experiment is to measure the acceleration of gravity, g, by studying the motion of a freely-falling object. This will be done using a free-fall apparatus with a spark timer which will record the vertical position of a freely-falling object as a function of time. The measured g will be compared to the accepted value of $9.80\,\mathrm{m/s^2}$.

II. APPARATUS

Behr free-fall apparatus with spark timer, waxed paper tape, plumb bob, and a ruler.

III. EXPERIMENTAL PROCEDURE

1. The lab assistant will run the free-fall apparatus with spark timer and produce a waxed paper tape which has a distance vs. time record of the motion of the falling object. This tape will be given to the student to analyze the free-fall motion.

2. Place the paper tape on the lab table and tape it. The position of the object is represented by sparks along the length of the tape. These sparks occur at equal time intervals but not equal distance intervals. The distance between each two consecutive sparks increases due to the acceleration of the falling object.

3. Neglect the first couple of sparks at the beginning of the tape due to the fact that they are very close to each other and measuring the distance between them is difficult. Select the first clear and well defined spark as your reference spark. Label the position there as $y_0 = 0.000\,\mathrm{m}$ and the time associated with it as $t_0 = 0.000\,\mathrm{s}$. The spark timer is timed to spark 30 times per second. The time interval between sparks is then $\Delta t = 0.0333\,\mathrm{s}$.

4. From the reference spark, carefully measure the positions of all the following sparks and record them in the data table.

IV. ANALYSIS

1. Calculate the velocities of the object at the locations of the sparks (do not calculate the velocities at spark 0 and the last spark). The velocity at spark 1 is $v_1 = (y_2 - y_0)/(t_2 - t_0) = (y_2 - y_0)/(0.0666\,\mathrm{s})$. The velocity at the nth spark is

$$v_n = \frac{y_{n+1} - y_{n-1}}{(0.0666\,\mathrm{s})}. \tag{1}$$

2. Plot the velocity on the vertical axis vs. the time on the horizontal axis. Draw the best straight line fit for the data.

3. Calculate the slope of this line. This is the acceleration of gravity as measured by this experiment. Give the units of the slope.

4. Calculate the percent difference between the measured value of the acceleration of gravity and the accepted value of $9.8\,\mathrm{m/s^2}$.

$$\%\text{ difference} = \frac{|\text{slope} - 9.80|}{9.80} \times 100 \tag{2}$$

5. Write a conclusion summarizing your results. Comment on the success of this experiment. Explain any percent differences larger than 5%. What do you think are the two most important sources of error?

Experiment (2) Data Table			
Spark Number	Time t s	Spark Position y (m)	Magnitude of Velocity $v = \frac{2\Delta y}{2\Delta t}$ (m/s)
0	0.0000	0.000	XXXXX
1	0.0333		
2	0.0666		
3	0.1000		
4	0.1333		
5	0.1666		
6	0.2000		
7	0.2333		
8	0.2666		
9	0.3000		
10	0.3333		
11	0.3666		
12	0.4000		
13	0.4333		
14	0.4666		
15	0.5000		
16	0.5333		
17	0.5666		
18	0.6000		XXXXX