LAB SECTION: ______________________________ NAME: ______________________________

EXPERIMENT 2: FREE FALL

Introduction: In this lab, you will measure the acceleration of an object as it falls toward the earth's surface. Air resistance should not be a factor, so the acceleration of the object should be g, the acceleration due to gravity. The value of g varies from place to place, being larger at lower elevations, but the average value of g is usually accepted as 9.8 m/s^2 or 980 cm/s^2

IMPORTANT: Special concerns for free fall experiment

1. Timer voltage is 30,000 volts - although not lethal, a shock from the timer is quite uncomfortable. Do not touch any metal parts of the free fall assembly when the timer is active (on). Turn the timer off between runs.

You will measure a set of distance changes, which we will denote as Δd's. You will know the Δt, the time interval for each of these distance changes. You can then get the **average speed** v_{av} from

$$v_{av} = \frac{\Delta d}{\Delta t}.$$

This will give you a sequence of average speeds. To get the change in speed Δv, all you need to do is to take the difference between two successive average speeds. The amount of acceleration a in that time interval Δt is then simply given by

$$a = \frac{\Delta v}{\Delta t}.$$

This procedure will give you a sequence of acceleration amounts; you can then take the average of these to get an overall result for your measured acceleration.

You will also determine the acceleration by making a graph of the sequence of average speeds versus time t. You won't really know the time at which the first average speed in your sequence occurs; we will call that time $t = 0$. This choice won't make any difference for us, because all we will need is the slope of the speed-versus-time graph. This slope will give us an alternative calculation of the overall amount of acceleration.

Procedure

1. A spark timer, attached to your falling object, will leave dots on a paper tape at equal time intervals; these dots will record the location of your falling object at those times. You will make three drops. After each drop, be sure to turn the timer off before

removing the paper tape for analysis. Then attach a new paper tape to your free fall assembly with which to record the next drop.

2. To analyze each tape, pick a dot, not too close to the beginning (where the dots might be very close together), and label that dot #1. Successive dots will be numbered 2, 3, 4, up to 11; this will give you 10 intervals. Measure the change in distance in each of the 10 intervals and record these Δd's in Data Table 2.1.
3. Record the Δt for your device at the top of Data Table 2.1. Then divide each Δd by Δt to get the average speed v_{av} in that interval; record these values in Data Table 2.1.
4. Find a sequence of Δv's by taking the differences between successive v_{av}'s. Record the difference between the first v_{av} and the second v_{av} in row #2, etc.
5. Divide each Δv by Δt to get the calculated amount of acceleration for each Δv. Record these values in the appropriate cells of Data Table 2.1; then take the average of the nine acceleration values to get the average acceleration for this run. Repeat for runs two and three in Data Tables 2.2 and 2.3 (for these last two Tables, write the average value of a in the margin to the right of row #10).

Data Table 2.1 Free Fall Run Number One $\Delta t =$ __________

Interval	Δd (cm)	v_{av} (cm/s)	Δv (cm/s)	a (cm/s^2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

average value of a ________________

Data Table 2.2 Free Fall Run Number Two $\Delta t =$ ________

Interval	Δd (cm)	v_{av} (cm/s)	Δv (cm/s)	a (cm/s^2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Data Table 2.3 Free Fall Run Number Three $\Delta t =$ ________

Interval	Δd (cm)	v_{av} (cm/s)	Δv (cm/s)	a (cm/s^2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Results

1. Select the Data Table that seems to have the "best run" data. State which table was chosen and explain the basis for your choice.

2. Using your best run data, make a graph of average speed versus time. Select the first value of average speed to have a designated time of $t = 0$. Each successive time will then be larger by an amount Δt. The slope of your speed-versus-time graph will then give you an alternative calculation of the average acceleration for this run. Write that slope on your graph, and show the calculation for that slope in the space below.

3. Calculate the percentage error between your slope value and the accepted value of 980 cm/s^2. Show that calculation in the space below.

4. Are you able to conclude that your falling object was falling with the acceleration due to gravity? Why or why not? What other force or forces might have been acting on your falling object other than the force of gravity? Are you able to make any conclusion about other possible forces on your falling object?