EXPERIMENT 4: FREE FALL

Introduction: In this lab, you will calculate the acceleration of an object as it falls toward the earth's surface. Air resistance will not be a factor, so the acceleration of the object will 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

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 $t = 0$. It won't make any difference for us, because all we 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 will leave a dot on a paper tape at equal time intervals; this dot will record the location of your falling object at those times. Draw a perpendicular line through each dot. 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 this Δd in Data Table 4.1.
2. Record the Δt for your device at the top of Data Table 4.1. Then divide each Δd by Δt to get the average speed v_{av} in that interval; record these values in Data Table 4.1.

3. Find a sequence of Δv's by taking the differences between sucessive v_{av}'s. Record the difference between the first v_{av} and the second v_{av} in row #2, etc.
4. 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 4.1; then take the average of the 9 acceleration values to get the average acceleration for this run. Repeat for runs two and three in Data Tables 4.2 and 4.3.

Data Table 4.1 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				

Data Table 4.2 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 4.3 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. Look over the data in your data tables, think about what the data mean, then 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. Record that slope here, along with any notes you may wish to record.

3. Use the slope and the accepted value of 980 cm/s^2 to calculate the experimental error.

4. Was the purpose of this lab accomplished? Why or why not? (Your answer to this question should show thoughtful analysis and careful, thorough thinking.)