

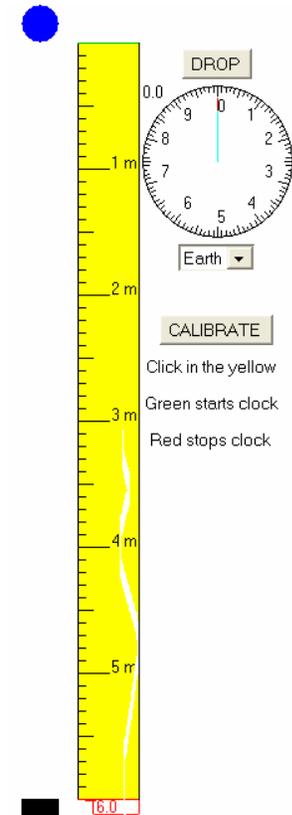
Acceleration of a Freely Falling Object: A Virtual Activity

Purpose:

1. Examine distance-time and velocity-time graphs of a freely falling object.
2. Determine the acceleration due to gravity of an object in "free fall."

Procedure:

1. Go to the web site <http://jersey.uoregon.edu/vlab/AverageVelocity/index.html>.
2. Complete Data Table I by running the simulation in order to determine through "trial and error" the distance the object falls during the specified times.
3. Use MS Excel to make a graph of "Total Distance Fallen vs. Time."
4. Use the "Add Trendline" function to determine and place the "best fit" equation on your graph.
5. Print your graph, making sure it is labeled properly.
6. How can you tell by looking at a position-time graph whether or not the object had a constant velocity (speed)?



Data Table I

| Time, s | 0.0 | 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 | 0.55 | 0.60 | 0.65 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.95 | 1.00 | 1.05 | 1.10 | |
|-------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|--|
| Distance, m | | | | | | | | | | | | | | | | | | | | | | | | |

To find out how the velocity (speed) changed and obtain the acceleration as the object fell, you must first calculate average velocities (speeds) of specific time intervals. For convenience, you will calculate the average velocity (speed) during every tenth of a second. You will then see how these speeds changed with time.

5. Subtract distances from Data Table I to find the distances the object fell during every tenth of a second. Record these distances in Data Table II as **Interval Distances**.
6. Calculate the average velocity (speed) during each of these intervals using the relationship **average speed = distance/time**. The time for each interval will be 0.10 s. Record these values in the data table.
7. Using the assumption that a freely falling object increases its speed uniformly, we can conclude that the average speed during the interval will equal the instantaneous speed at the time halfway through the interval. Therefore, the instantaneous velocity (speed) at time $t = 0.15$ s will be the same as the average velocity (speed) during the time from $t = 0.10$ s to $t = 0.20$ s.

Data Table II

| Time Interval, s | Time of Interval, s | Interval Distance, m | Average Velocity for Interval, m/s | Avg. Vel. = Inst. Vel. at Time..., s |
|------------------|---------------------|----------------------|------------------------------------|--------------------------------------|
| 0.00 - 0.10 | 0.10 | | | 0.05 |
| 0.10 - 0.20 | 0.10 | | | 0.15 |
| 0.20 - 0.30 | 0.10 | | | 0.25 |
| 0.30 - 0.40 | 0.10 | | | 0.35 |
| 0.40 - 0.50 | 0.10 | | | 0.45 |
| 0.50 - 0.60 | 0.10 | | | 0.55 |
| 0.60 - 0.70 | 0.10 | | | 0.65 |
| 0.70 - 0.80 | 0.10 | | | 0.75 |
| 0.80 - 0.90 | 0.10 | | | 0.85 |
| 0.90 - 1.00 | 0.10 | | | 0.95 |
| 1.00 - 1.10 | 0.10 | | | 1.05 |

8. Use MS Excel and the last two columns in Data Table II to make a graph of "Instantaneous Velocity vs Time."
9. Use the "Add Trendline" function to determine and place the "best fit" equation on your graph.
10. Print this graph, making sure it is labeled properly.

Discussion Questions:

1. The slope of your "Instantaneous Velocity vs Time" graph should be the value of the object's acceleration.
The slope of our graph is _____.
2. Make a statement comparing your acceleration to the accepted value of 9.8 m/s/s.
3. Look at the equation for your "Total Distance Fallen vs Time" graph. How can you determine the value of the gravitational acceleration from that equation?
4. Even though this activity was performed using a computer simulation, your results may not be in exact agreement with the accepted value for gravitational acceleration.
What are some reasons why an activity such as this might still have error in it?

Extension Idea: Repeat this process simulating free fall on Mars or the Moon.
(not required, but something else that could be done)