

Physics

Name: _____

Lab - Free Fall

Purpose: To measure the acceleration of gravity using a spark timer.

Materials: Spark Timer stop watch
support rods ruler mass piece

Discussion: Ignoring air resistance and differences in the gravitational pull due to altitude, all objects fall with the same rate of acceleration in the Earth's gravitational field. To determine the rate of acceleration, g , one can allow an object to drop and use a spark timer to record the motion of the object. The tape can be analyzed and the equations of kinematics used to calculate the acceleration of gravity. This rate of acceleration has been measured to be 9.81 m/s^2 near the surface of the earth. In this experiment you will try to verify that result.

Procedure:

****PRECAUTIONS: The spark timers have two settings, 60Hz and 10Hz. Be sure your timer is set to 60Hz. Please use a falling mass that will not damage the floor. Place a book or magazine on the floor to prevent damage.**

- (a) Set up your spark timer in an orientation that minimizes friction. Run a strip of paper through the timer and drape it over a support rod that is hanging over the edge of the table.
- (b) Tape a mass piece to the end of the strip. Be sure that the mass piece can fall uninhibited to the floor.
- (c) Remove any slack from the paper strip. Start the timer and let the mass piece fall.
- (d) Measure the distance between the dots on the paper strip and record this in Data Table 2.

Analysis:

- (a) Starting with the first clear dot **after** the blob of dots made by the timer before dropping the mass, carefully measure the distance between each dot on the strip and your starting dot (for 20-30 dots). If the dots are very close together and you have over 50 you can measure the distance between every two dots. If so, be sure to adjust your Δt accordingly.
- (b) Calculate the distance between each successive dot. Enter this in your table as the values for Δy ($y_2 - y_1, y_4 - y_3$, etc....)
- (c) Calculate the *velocity* over each interval using the formula $v = \Delta y / \Delta t$. (XC opportunity: Propagate your error.)
- (d) Find the *change in velocity* between each interval ($v_2 - v_1, v_3 - v_2$, etc...).
- (e) Calculate the *acceleration* by dividing Δv by $2(\Delta t)$. This is so because for

each measurement of a you are using four measurements of v , that is, two time intervals.

(f) Find your average acceleration (Note, you may wish to drop off your highest and lowest value before averaging in order to get a better estimate. Propagate your error. Calculate your percent of error from the accepted value.

(g) Draw a graphs of *position*, *velocity*, and *acceleration* verse time by plotting points and drawing a *line/curve of best fit* through your data points. Show an equation of your best fit on each graph. Determine the slope of the graph of velocity vs. time and compare this to you average acceleration from the data table. Why are they different? Compare your experimental findings to the known value for acceleration of gravity.

Questions:

1. Why do you have to remove the slack before letting the mass fall?
2. How would your results differ if you used a mass piece that was 400g instead of 200g?
3. How does the slope of your graph compare to the average value of acceleration? How doe they compare to the known value?
4. How long would it take to hit the ground if you jumped off a building that was 800ft tall (into a net, of course!).
5. Would you expect different results if you did this experiment in Denver, CO? Explain.
6. Determine the depth of a well if you drop a stone into it and the sound takes 12.2s to get back to your ears...

**Error
Analysis:**

Discuss any sources of error in this lab and describe ways that you could improve the accuracy.

Conclusion:

What did you accomplish in this lab? What were the main concepts studied or discovered? (Task, Results, Generalization...)

Extension:

Use the Classroom computer and photogate timing system to measure the acceleration of gravity. Record this somewhere and compare it to your value. Discuss the ways in which technology allows you to make calculations and analyze date more effectively.