
PHYSICS 125 EXPERIMENT NO. 2

ACCELERATION

Introduction

In this experiment first we learn how to use the computerized lab equipment. Then, we measure the gravitational acceleration constant g .

Equipment

One computer, one photogate, one interface box, one plastic ruler and masking tape.

Method

By dropping a ruler through a photogate, an old-style “electric eye,” we can infer the rate at which an object will accelerate due to the earth’s gravitational force. The clear, plastic ruler will be marked at regular intervals with masking tape that will block the light in the photogate and turn on and off the timer in the computer. The times will be recorded in the computer and displayed on the monitor. Using the distance between successive pieces of masking tape and these times, the computer will perform the calculation of the average velocity of the ruler in these intervals during its fall. The results can be displayed graphically on the monitor in various instructive ways.

Procedure

1. PREPARING THE RULER: Lay a piece of masking tape across the ruler so that it lines up exactly with the 0 cm marker line. Then lay down the next piece tightly against the first one. Repeat the procedure until the tape covers the entire length of the ruler. Starting from the second piece, peel off every other piece of tape so that the ruler looks like a blunt “picket fence.” Lay the peeled off tapes directly over the ones on the ruler so that you end up with a double thickness. This makes the tape block the light more efficiently. Trim off any extra tape.
2. Measure the interval d between the two successive leading edges of the tape pieces; i.e., one piece of tape and one blank spot. To do it more accurate, measure the distance from the first leading edge to the last one and divide it by the number of intervals between them. *Why is this more accurate?*
3. Connect the photogate output to the interface box by plugging its cable into the first socket of the interface box.
4. Turn on the computer and check the system by following the instructions (steps 1-5) given in the separate sheet entitled “Computer Instructions.”
5. Now we are ready to take data. Press “M” or use the cursor keys to highlight “MOTION TIMER” on the screen. Then press “ENTER.” push the “SET” button on the interface box to permit the flow of data to the computer. Hold the ruler just above

the photogate and drop it between the fingers of the photogate so that the tape that was carefully applied to the ruler interrupts the light path. The computer will give a high-pitched whistle while the measurement is in progress. Push the "STOP" button on the interface box after the ruler has fallen.

6. A table of the time intervals will appear on the screen. By hitting "ENTER" and following the choices for graphing the data, plots of displacement vs. time, velocity vs. time, and acceleration vs. time can be seen. *What can you say about the shape of the arrangement of points in each plot? Could you easily fit a straight line through the data in each of the plots?*
7. Write down a table of values of velocities from the computer monitor in your lab book, and make a plot of velocity vs. time. The velocities are put on the "y" or vertical axis, and the times on the "x" or horizontal axis. By eye, fit a straight line through these points. Calculate the slope of this line to determine the gravitational acceleration constant g which is the average rate of change of the velocity of the ruler as it falls. Next, fit a line that would have a larger slope and one with a smaller slope than the first one (The lines should still fit the data reasonably). These two additional lines should give an indication of the uncertainty in the slope of the first line. Calculate the slopes of the lines and determine the uncertainty in the previously measured value g . *Are error bars appropriate in this plot? How would you determine them?* (See separate write-up on errors)
8. The computer program has the facility to determine the slope of the line in the "Statistics" section. It will give the slope and the uncertainty in the slope. Record its result in your lab book for this run. Compare the values with the ones you have determined in your lab book from the procedure No. 7 above. Repeat the experiment four more times to determine four more g values in this way. We do not need to record the individual velocities in these additional runs! For each run just write down the g value and its uncertainty from the computer. From these values, calculate the average gravitational acceleration constant $\langle g \rangle$ and its associated uncertainty. *How does this value compare with the value given in the textbook? If there is a discrepancy, what can be the possible sources for it?*
9. You might try dropping the ruler from above the photogate to give it an initial velocity before breaking the beam. *What effect does this have on the acceleration, or the straightness of the line?*

REFERENCE: Chapter on motion in 1 dimension in your physics text book. You should read the text before coming to lab. Be prepared to answer questions about Instantaneous vs. Average velocity. It makes understanding the lab a lot easier if you do the reading first.