SAN DIEGO MESA COLLEGE
PHYSICS 100 LAB REPORT

TITLE: Measurement of "g"

Name___________________________
Date __________**Time**___________
Partners_______________________
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Objective: To calculate the acceleration due to gravity, in the lab, by analyzing the non-uniform motion of a freely falling object.

Theory: The motion of an object is described by its equation of motion, which relates its change in position to a change in time. For a body in free fall, position and time are not related by a constant velocity as they were for uniform motion. During free fall, the distance traveled during each time interval increases. Thus, the velocity increases with time which means the object is accelerating.

The average velocity is the distanced traveled during a time interval divided by the length of that time interval:

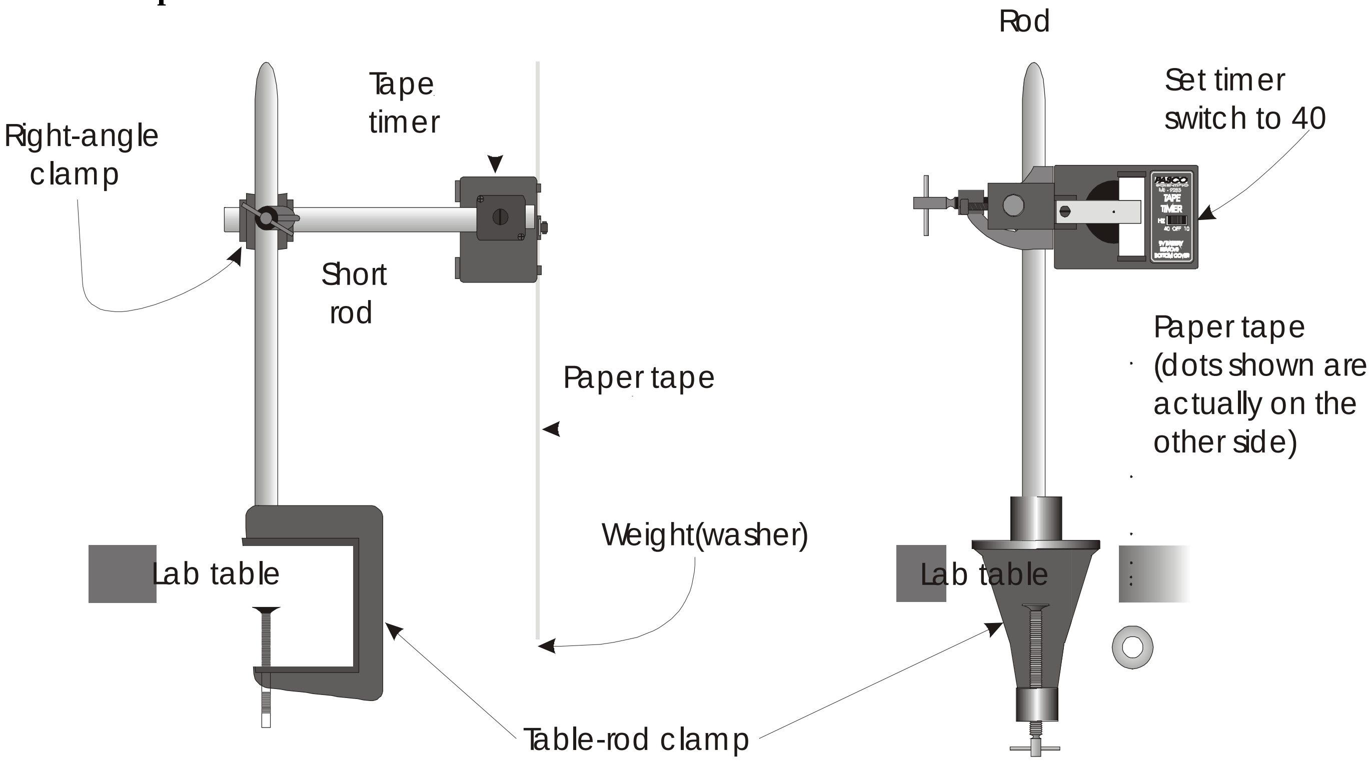
average velocity = displacement during time interval ÷time interval

The average acceleration over an interval is then:

average acceleration = change in velocity during time interval ÷ time interval

Equipment:
Tape Timer
Tape Timer Mount w/ Paper Feeder
2 meter Paper Strip
Weight for paper strip (metal washer)
Meter Stick
Masking tape
Bubble Level

Setup:



Procedure:

Make sure the tape timer is hanging vertically over the edge of the table and make sure the timer is level in both directions by placing level on top of timer.
Feed one end of the paper strip through the top plastic slot, in between the silver bar and the circular carbon paper, and out the bottom plastic slot. If you have difficulty, try slightly bending the end of the paper strip up.
Have one lab partner lay the paper strip up and over the feeder bar and hold onto the paper strip near the feeder bar.
Have a 2nd lab partner attach a washer via masking tape to the end of the paper strip that was fed through the tape timer.
For this lab we will use the 40 Hz setting of the tape timer. So have a lab partner move the switch on the tape timer to the 40 Hz position and turn the tape timer on.
Have the lab partner holding the paper strip let go and move their hand off to the side of the strip, out of the way of the moving strip. You can affect your data if this partner's hand interferes with the motion of the strip.
Move the timer switch to the off position.
Remove the washer.
Take a look at the underside of the strip (the side facing the table) to see if the marks are easily visible (they may be small, but they should be dark).
Skip the first several dots and choose 8 clean and dark points.
If the marks aren't visible, try rotating the circular carbon paper half a twist or less, and repeat the procedure.

Data:

DOT #		Position (cm)
1	+	
2	+	
3	+	
4	+	
5	+	
6	+	
7	+	
8	+	

Position (c m)	*Time (s)	Displacement Interval (c m)	Average Velocity (c m/s)
0	0		

Analysis:

Look at the paper strip. The side where the mass was attached is the beginning of the strip. The dots should look closer together here than on the other end.

Choose the first clean and fully dark dot as your dot #1. This will be your first data point.

Place dot 1 on the zero mark of your measuring stick. Record the position of the other 7 dots.

Calculate and record in the data table the distance interval, Δx (change in ruler position) between each pair of adjacent points.

For this experiment we used the 40 Hz setting. This corresponds to a time interval between any two marks of 0.025 seconds ($\Delta t = 0.025$ s).

The average velocity between two points is:

$$\text{average velocity} = \Delta x \div \Delta t$$

The values for average velocity for a particular time interval can be used to solve for the average acceleration between any two time intervals. The average acceleration is the change in velocity divided by the elapsed time between the two velocity values.

Use the last data table entry for average velocity as V_{final} and the first entry for average velocity as $V_{initial}$.

There are 6 time interval between the first and last average velocity values. This correspond to an elapsed time, Δt, of 6/40 = 0.15 seconds.

The mathematical relationship for average acceleration is then:

$$\text{Average acceleration} = (V_{final} - V_{initial}) \div \Delta t$$

If the acceleration in the lab is fairly constant, then the average acceleration is approximately (neglecting friction and air resistance) the constant acceleration due to gravity.

Solve for the acceleration due to gravity using this formula. Show your work below

The equation of motion for our approximately free falling object can be determined from the graph of velocity as a function of time. The object's velocity is always changing. It is going faster than the average velocity at the end of an interval and slower than the average at the beginning.
For a constant acceleration, the actual velocity at the center of the time interval is the same as the average velocity over the interval.

Plot the velocity versus the time interval center.

Calculate the slope of this graph. Remember one interval = 1/ 40s = 0.025s. Convert your slope to cm/s^2. Show all your work including units below. Remember to circle on your graph the two data points that you are using to determine the slope.

Calculate the % difference between the value of acceleration derived from the data table with the value of acceleration derived from the slope of the velocity vs. time graph.

% difference = (difference between the two values ÷ the larger of the two values) x 100

What then is the physical interpretation of the slope of the velocity- time graph?

What is the name given to this constant that relates the changing velocity of a freely falling object and the time it takes to fall?

Write the equation of the graph in the form:

$V(cm/s) = V_0 + at$

Where V_0 is the vertical intercept of your graph with units of cm/s, a is the slope of your graph in units of cm/s^2, and t is in seconds.

If a ripe watermelon that is dropped from the top of an eight story building and falls for 2.40s has the same freefall acceleration that you determined from YOUR graph, calculate the speed in miles per hour that the melon would hit the ground. Show all work and unit conversions below.

Summary of Results:

What is the acceleration of an object due to gravity?