

GENERAL SCIENCE LABORATORY 1110L Lab

Experiment 4: THE SIMPLE PENDULUM

Objective: To determine the local acceleration of gravity by a different method and to investigate the relationship between the length of a pendulum and its oscillation period.

Apparatus: Pendulum bob and string, pendulum clamp, aluminum pole, large clamp, stopwatch, and meter stick.

Theory: A simple pendulum consists of a bob (a spherical mass) hung from a fixture by a very light string of length L . The mass of the string is much less than the mass of the bob. (In truth according to the equation below it should be massless). In the case of our lab, the monofilament fishing line we will use is a very close approximation to a massless string. The oscillation period, T , is the time it takes the bob to make one complete cycle of oscillation. If L is much greater than the radius of the bob and the amplitude is small ($\theta < 5^\circ$ See figure 3), then the period of a pendulum is given by:

$$T = 2\pi \sqrt{\frac{L}{g}} \quad (1)$$

The gravitational acceleration, g , can then be expressed in terms of the length and the period of the pendulum by solving for g from the above equation.

$$g = (4\pi^2 L)/T^2 \quad (2)$$

Note: Air resistance is ignored.

Procedure:

1. **Clamp the large clamp to the end of the table so that the groove in the metal is vertical.**



Figure 1: LARGE CLAMP

2. **Place the aluminum pole in the groove and tighten up the screw.**
3. **Clamp the pendulum clamp to the top of the Aluminum pole.**

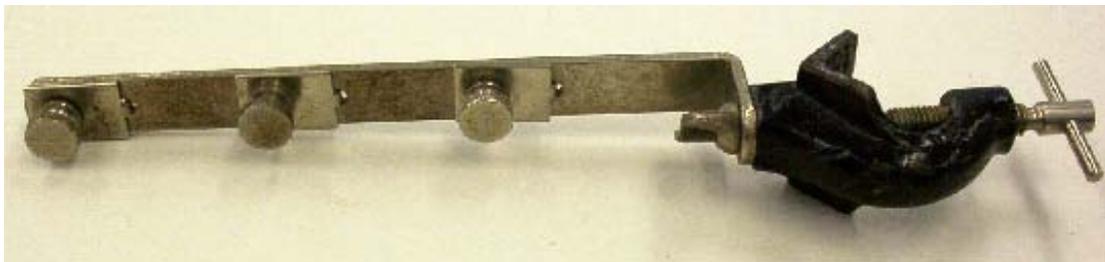


Figure 2: Pendulum Clamp

- Loosen the black knobs at the either end of the clamp and place the string that the bob is hung from, behind the two metal fingers that are behind the black knob.

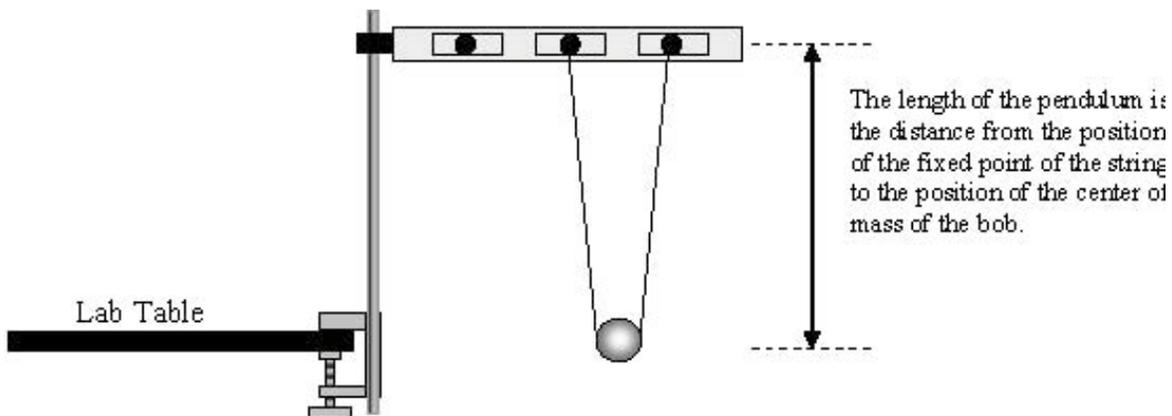


Figure 3: Experimental Setup

- Tighten the knob to hold the pendulum at the correct length. 20 cm to start (You will loosen the knob and adjust the length of the pendulum as called for in your data table). You will measure the length of the pendulum from the bottom of the pendulum clamp to the center of the bob.
- Pull the bob 5° or less from the equilibrium position. (This is the dotted line in the picture below and represents where the pendulum hangs when it is still)

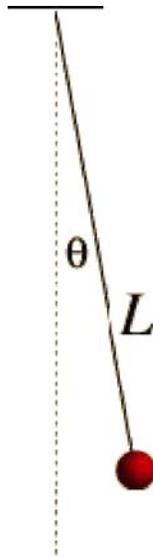


Figure 4: Simple Pendulum at the beginning of its oscillation.

7. Let the pendulum swing several times until it swings at a steady state.
8. Get the stop watch ready and when the bob comes back to you and comes to a stop at the top of the swing start the stop watch.
9. You will measure the time for 20 cycles. One cycle is the time it takes to go from where you released the bob to the opposite side of the swing and then comes back to where it started. Remember you do not count one until the bob comes back to you for the first time.
10. At the end of the twentieth cycle stop the stop watch.
11. Record the length, L , in cm and the total time t for twenty cycles in seconds, to the nearest 100th of a second. Record these values in the proper columns in your data table.
12. Repeat this measurement with different pendulum lengths of 40.0 cm, 60.0 cm, 80.0 cm, and 100.0 cm. Record the values for L and t in your data table.

DATA ANALYSIS

1. Determine the period of oscillation, T , for each length by using equation (3) and place the result for each length in your data table.

$$T = \frac{t}{20} \quad (3)$$

2. Calculate the acceleration of gravity using equation (2) and place the result in the proper column of your data table.
3. Find the average acceleration of gravity and place the result in the proper place in your data table.
4. Compare this experimental value of g with the accepted value of 9.80 m/s^2 using equation number 4.

$$\% \text{ error} = (g_{\text{avg}} \text{ m/s}^2 - 9.80 \text{ m/s}^2 / 9.80 \text{ m/s}^2) \times 100 \% \quad (4)$$

Format for Suggested Data Table in your Lab Notebook

Total number of Cycles t : _____

Length of Pendulum in (cm)	Total Time t in seconds	Period in seconds	Acceleration of gravity g in m/s^2
20.0			
40.0			
60.0			
80.0			
100.0			

Average $g =$ _____ $(\text{cm/s}^2) =$ _____ (m/s^2)
% error = _____ %

QUESTIONS

1. How would you reduce the error in the total time measurement by changing your measurement?
2. Would any other shape other than a sphere be a better shape for the bob?
Why or why not?
2. How does the period of a pendulum change when its length is quadrupled?
(Hint: see both equation (1) and your data table)

Lab Report Format

Your lab report for this experiment should have the following sections:

1. Title of experiment in center of the first page. Date to the left of the title. Experimenters name with partners name(s) under experimenters name to the right of the title.
3. Objective
3. Apparatus
4. Original Data: Neatly filled out data page.
5. Sample calculations: For this lab, an example (ONE) needs to be shown for each of the following calculations: Period (T) calculated (for one of the lengths) using one of the total times t, g (for one of the lengths), g_{average} , and the % error.
6. Results: State your results (in the form of a **very short** sentence). Make sure the numerical results are properly rounded and have the correct number of significant digits. Show your experiential result for g. Compare your result for g to the true value by stating the percent error.
7. Conclusions: Address the answers to the three discussion questions above.

PROPER MATERIALS, ETC. FOR YOUR REPORTS

1. ALL DATA IS TO BE RECORDED DIRECTLY IN YOUR LAB NOTEBOOK. **NO SCRATCH PAPER IS TO BE USED.**
2. YOU ARE TO USE BLUE OR BLACK INK ONLY FOR RECORDING DATA AND DOING YOUR REPORTS IN YOUR NOTEBOOK.
3. REMEMBER, ONLY THE FRONT OF THE PAGES IN YOUR LAB NOTEBOOK ARE

TO BE USED FOR DOING YOUR LAB REPORT. I WILL NOT LOOK AT ANY INFORMATION ON THE BACKSIDE OF THE NOTEBOOK PAGES.

4. DO NOT TEAR OUT ANY PAGES FROM YOUR NOTBOOK.

1. DO NOT ERASE OR USE WHITEOUT FOR MISTAKES!!!!

All observations taken under the same experimental condition are equally valid and should be retained for analysis. Do not erase readings. If you must change a reading, draw a single line through it and then record the new measurement next to the old one.