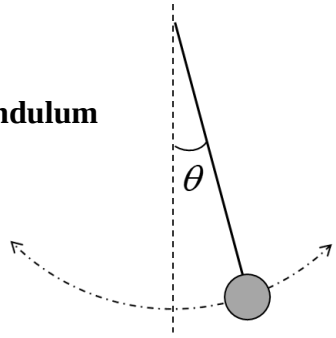
Measuring the Acceleration due to Gravity (g) using a Simple Pendulum



Purpose

To measure the acceleration due to gravity, $\boldsymbol{g}$, using a simple pendulum.

Introduction and Theory

A simple pendulum consists of a mass $\boldsymbol{m}$ attached to the bottom end of a long string of length $\boldsymbol{L}$. The top end of the string is attached to a pivot. The mass is pulled to the side with an angle $\boldsymbol{\theta} < 15^{\circ}$, and released. The mass oscillates back and forth with a period $\boldsymbol{T}$. The period of the oscillation (the time to complete one cycle of oscillation) is:

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

Take a few moments to study this equation: How would the period change if the length of the string were made longer? If the mass at the end of the string was larger? How would things change if you did this on the Moon?

You can measure the length of the pendulum and the period of oscillation, and using a bit of simple algebra, calculate the value of $\boldsymbol{g}$:

$$\boldsymbol{g} = \boldsymbol{L}\left(\frac{2\pi}{\boldsymbol{T}}\right)^2 \qquad (2)$$

Thought Questions (Answer these questions in your report after the Apparatus section.)

a. An old-fashioned grandfather clock runs as a simple pendulum. How would you adjust the clock if it were running too fast?
b. What object would you attach to the bottom of the string to minimize air friction and to prevent spinning?
c. How would you make sure that $\boldsymbol{\theta} < 15^{\circ}$?
d. How would you hang the string to make sure the pendulum does not swing against any surface?

Writing a lab report

A lab report template is provided on pages 3 and 4. The template is for reference only. You should write your own lab report on single-lined paper and follow the instructions in this lab manual. Your report should always contain at least 5 parts: Purpose, Apparatus, Data, Calculations and Conclusions. Some labs, like this one, also contain a Discussion section. Refer to "Lab Report Requirements" and "Sample Lab Report" for details.

Apparatus

Draw a labelled schematic diagram and list (identify) any apparatus used, including: meter stick, long string (between 75cm and 1.2m), pendulum bob and stopwatch.

You will need to attach your pendulum to the metal stand so that it is free to swing through a small angle. See the demonstration video for reference.

Data

Measure and record the length $\boldsymbol{L}$ of the pendulum. The length of the pendulum is the distance between the pivot point and the center of mass of the pendulum. Determine the uncertainty of the length of the pendulum based on how precise you can locate the position of the pivot point and the center of mass of the pendulum.

From its lowest position, move the bob of the pendulum to one side such that the string makes an angle of 5° with the vertical. Release the bob. Use a stopwatch to measure the time of 20 completed cycles of oscillation. Repeat this process 3 times and record the results in a data table (see the lab report template).

The uncertainty of the time depends on your reaction time. Measure the latter by pressing "Start" then immediately pressing "Stop" after. Use the reading as the uncertainty. (How many digits do you have for your three readings?
How many of them are significant figures?)

For checking, record and measure the time of 5 completed cycles of oscillation. Repeat this process 3 times and record the results in a data table.

Calculations

Calculate the average time of the 20 completed cycles based on the 3 readings and write it down in the data table. Then, calculate the measured period (time for 1 completed cycle). The period $\boldsymbol{T}$ is equal to the average time of the 20 cycles divided by 20.

Similarly, calculate the measured period from the average time of 5 completed cycles. Does the period calculated from 5 cycles agree with the period calculated from 20 cycles? If not, please check your data and calculations.

Use the period $\boldsymbol{T}$ calculated from the 20 cycles and the length of the pendulum $\boldsymbol{L}$ to calculate the acceleration due to gravity $\boldsymbol{g}$ with Equation (2). State the equation with symbols first and keep units in all the calculation steps. Do NOT round your numbers in each step and underline the location of the last significant figure of each measured/calculated number.

The reference value of the acceleration due to gravity is $\boldsymbol{g_{\mathrm{ref}}} = 9.81\ \mathrm{m/s^2}$. Calculate the percentage discrepancy between your value and the reference value:

$$\text{Percentage discrepancy} = \frac{|\text{your value} - \text{reference value}|}{\text{reference value}} \times 100\%$$

Conclusions

State your result in a full sentence, in $\mathrm{m/s^2}$, with the correct number of significant figures, and compare it to the reference value.

Discussion

State if your result is acceptable to you or not and include a reasonable argument. Do you have any suggestions on improving this experiment? If you used a different length of pendulum, would you get a better/worse result? Please explain, don't simply say "better" or "worse".

Your name
Partner's name(s): _____
Physics 1118 Section #: _____
Desk #: _____
Date: _____

Measuring Gravity g using a Simple Pendulum

Purpose

(Write the purpose of the lab here. Keep it in mind as you work.)

Apparatus

(Follow the instructions on the lab manual.)

Thought Questions

(Write down your answers to the thought questions here.)

Data

Length of pendulum (pivot to center of mass) L = _____

Trial Number	Time for 20 cycles (s)	Time for 5 cycles (s)
1		
2		
3		
Uncertainty		
Average time		

Calculations

(Write down all the calculation steps for period and acceleration due to gravity here.)

The reference value for g is _____.

Percentage discrepancy =

Conclusions

The value of the acceleration due to gravity, g, was found to be _____, which is _____ than the reference value of _____.

Discussion:

(See the lab manual for what to write here.)