

PHY 151/251
Lab 9 – Simple Harmonic Motion

Objectives:

The objective of this experiment is to compare experimental observations of the period of a simple pendulum to theoretical calculations of the period.

Theory:

A simple pendulum consists of a point mass suspended from a stationary point by a massless string in a uniform gravitational field. Such a pendulum will undergo periodic motion which is very nearly simple harmonic motion, provided that the angular amplitude is small. At larger angles, the motion is still periodic, but it differs from simple harmonic. While the uniform gravitational field is experimentally realistic, the point mass and massless string are a matter of scale: instead of a point mass, the length of the mass should be small compared to the overall length of the pendulum, and the mass of the string should be small compared to the mass attached to the string.

The simple harmonic period for a simple pendulum is given by the expression

$$T = 2\pi\sqrt{\frac{l}{g}} \quad (\text{Eq. 1})$$

where T is the period in seconds, l is the length of the string from the suspension point to the point mass in meters, and g is the magnitude of the gravitational acceleration in meters per second squared.

Procedure:

1. Measure and cut a piece of string about a meter long. Tie a loop in one end for a hooked mass.
2. Set the support arm above the table top. Attach a 100 g mass to the string, and tie the string to the support arm so that the pendulum is between 70 and 80 cm long.
3. Measure and record the actual distance from the support point to the topmost “edge” of the mass.
4. Time 10 small angle oscillations (less than 10 degrees). Do this 3 times, recording each time separately. Be sure that you count the oscillations correctly (when you start the watch, don’t say “one”). From this data, calculate the experimental value for period ($T_{\text{exp}} = t_{\text{avg}}/10$).
5. Replace the 100 g mass with a 200 g mass and repeat Procedure 4. **Be sure that your pendulum length l does not change.**
6. Shorten the pendulum to between 40 and 50 cm, and repeat Procedures 4 and 5.

Calculations

1. From the data of Procedure Step 3, calculate the theoretical period of the pendulum by using (Eq. 1). Determine the percent error between the experimental observations of the period for the 100 g and 200 g masses with the theoretical calculation of the period.
2. From the data of Procedure Step 6, calculate the theoretical period of the shorter length pendulum and determine the percent error between the experimental observations of the period for the 100 g and 200 g masses with the theoretical calculation of the period.