Simple harmonic motion is a sinusoidal periodic motion that can be described by the equation

\[ y = A \sin \omega t \]

where \( y \) is the displacement, \( A \) is the amplitude of the motion, \( \omega \) is the angular frequency, and \( t \) is the time. Recall that \( \omega = 2\pi f \) where \( f \) is frequency, and the period \( T \) is related to \( f \) by \( T = \frac{1}{f} \). In today's lab you will study simple harmonic motion with both the simple pendulum and a mass on a spring.

Simple harmonic motion is used as a model to study bipolar disorder.\(^{1} \) Patients with bipolar disorder will have mood changes between hypomania and major depression which may be modelled with a harmonic oscillator where mood stabilizers can limit the oscillations by effectively damping the oscillations.\(^{2-4} \) In nature there are many things that obey simple harmonic motion.

In the Simple Pendulum lab, you will measure the period of a pendulum (ball attached to a string) by timing the number of oscillations.\(^{5} \) You will divide the total time by the number of cycles to get the period of the pendulum. You will show that the period only depends on the length of the pendulum (measure to center of mass of ball) and the acceleration of gravity for small angles. You will also see that the pendulum obeys simple harmonic motion at small angles.

When the pendulum swings to the endpoints, it changes direction so the magnitude of the velocity is zero, but the acceleration is at a maximum since the velocity is changing in direction. The potential energy is at a maximum since the velocity is changing in direction. When the pendulum swings to the center, its velocity is at a maximum at the endpoints. When the pendulum swings to the center, its velocity is at a maximum, its acceleration is at a minimum, and its potential energy is zero. Its kinetic energy is at a maximum here since its velocity is at a maximum. Go to https://phet.colorado.edu/sims/html/pendulum-
Go to [https://phet.colorado.edu/sims/html/pendulum-lab/latest/pendulum-lab_en.html](https://phet.colorado.edu/sims/html/pendulum-lab/latest/pendulum-lab_en.html) and doubleclick on “Intro.” Make sure that the Stopwatch is checked. Adjust the length of the string to 0.70 m and the mass to 1.00 kg. The gravity should be that of Earth, and no friction should be applied. Move the mass to 5°. Start the stopwatch when the mass comes back to 5° and count ten oscillations and stop the stopwatch. What is the period of the pendulum (take your number and divide by 10)?

2. Repeat this for a few angles. About what angle does the period start to change (when the small angle approximation no longer holds)?

3. Change the length of the pendulum to 0.4 m. What is your period at 5°?

4. Keep the length at 0.4 m, and change the mass to 1.3 kg. What is your period at 5°?

## Things to consider when doing the lab:

1. The length of the pendulum is from the pivot point to the center of mass of the ball.

## References:


7 https://www.youtube.com/watch?v=i2GdY1OlDpA

8 https://www.youtube.com/watch?v=EZNpnCd4ZBo