Galileo’s Law of the Pendulum Activities

One day, when he was inside the Pisa Cathedral, Galileo became interested in the motion of a chandelier that workmen had accidentally caused to start swinging. Using his pulse as a timing device, Galileo noticed that the time it took the chandelier to swing through one full out-and-back cycle (known as the *period*) remained the same no matter how widely the chandelier was swinging. He became curious and later designed three simple experiments to learn more about a pendulum.

Definitions:

Bob: the *mass* on the end of a pendulum (see Figure 1)

Displacement: the *distance* a pendulum is pulled back from its resting point before it is released (see Figure 2)

Period: the *time* it takes for a pendulum to swing through one full cycle. (Out and back again to the point of release) (see Figure 3)

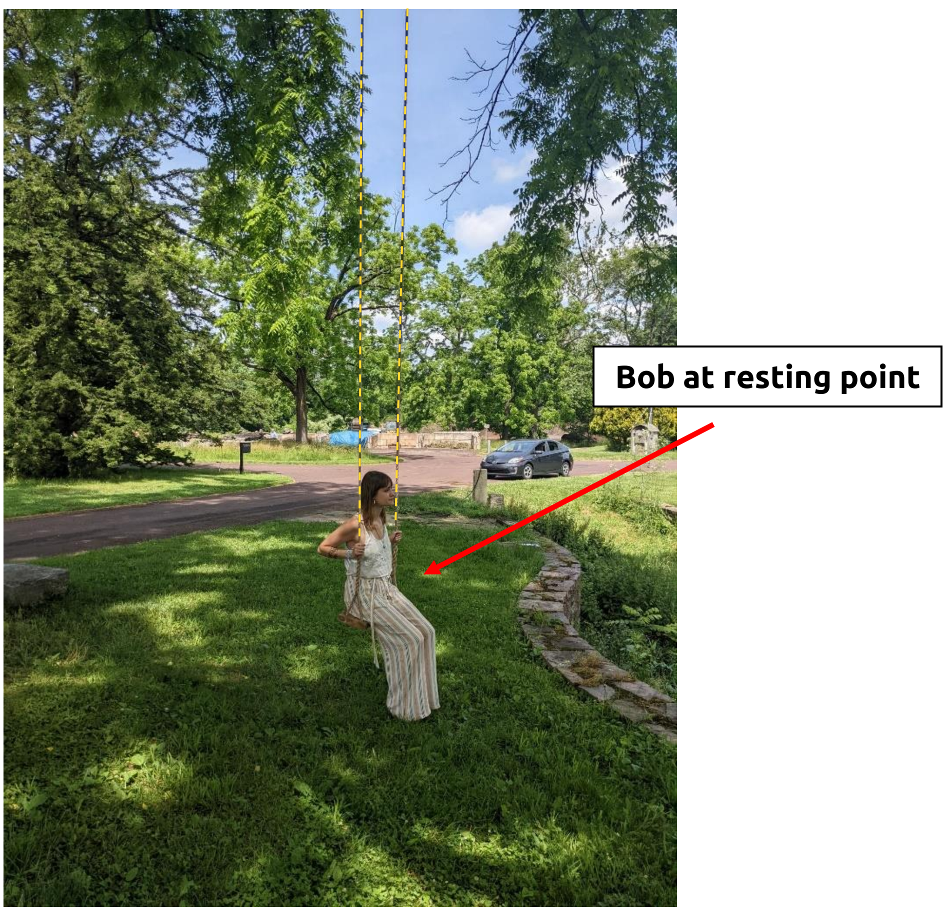

Figure 1: Resting Point

Figure 2: Displacement

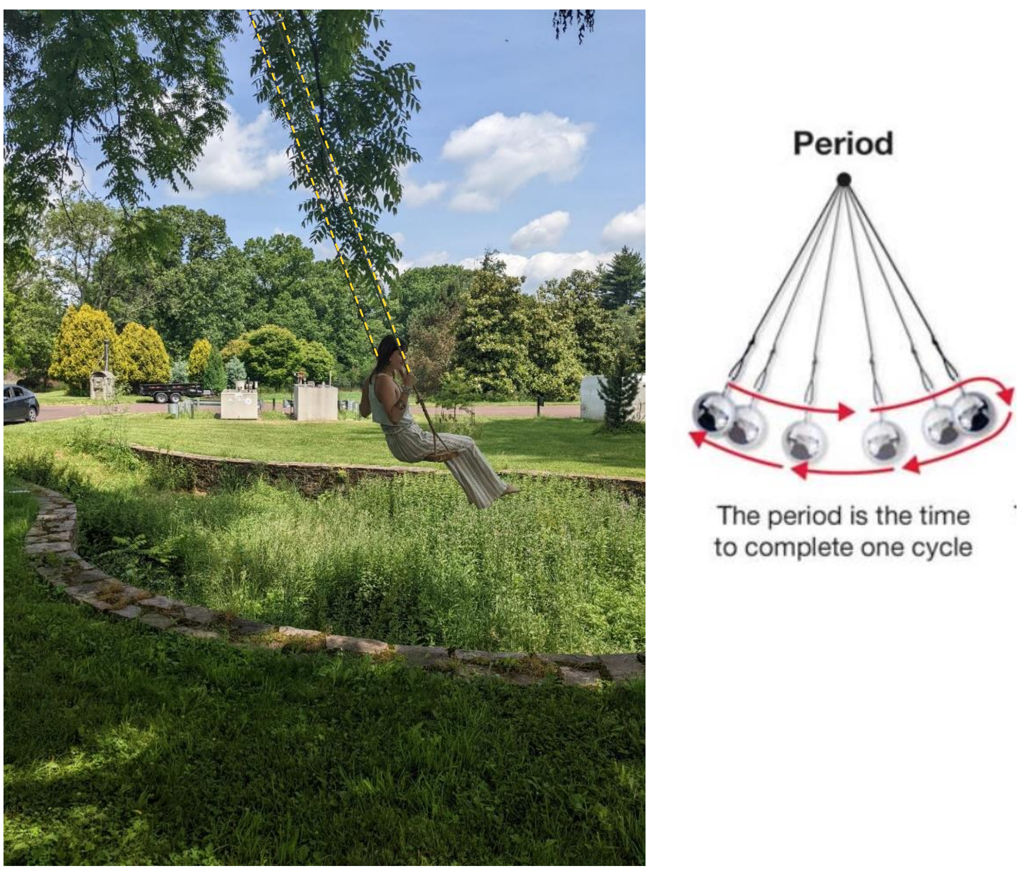

Figure 3: Period

We suggest have three people to perform the following demonstrations: a swinger, a releaser, and a timer.

Demonstration #1: Changing Displacement

Pull a person seated on the swing back about three steps. Using the stopwatch function on a phone, record the time it takes the person to complete five full swing cycles. (Timing five cycles yields more reliable results than timing just one cycle.)

Next, pull the same person back about half that distance (half the *displacement*) and time how long it takes to complete five cycles.

How do the two times compare? Is the difference, if any, significant? So, does changing the displacement of the pendulum cause the time you recorded to change? Galileo concluded that the displacement does not affect the time for the pendulum to complete a cycle.

Demonstration #2: Changing Weight

For this demonstration, try a different swing in the Arboretum. You will need two people of different weights.

Galileo wondered if changing the weight at the end of a pendulum (known as the *bob*) causes the *period* to change. Remember, the *period* is the amount of time it takes to complete a full swing cycle.

Pull the first person back the same number of steps (*displacement*), release them, and time five cycles.

Next, have a person of a different weight sit on the swing. Pull that person back to the same *displacement* as the first person, release, and record the time for five cycles.

How do the two times compare? Is the difference, if any, significant? So, does changing the weight of the bob of a pendulum cause the time you recorded to change? Galileo concluded that the weight of the bob does not affect the time for the pendulum to complete a cycle.

Demonstration #3: Changing Rope Length

For this final demonstration, you will need to collect and compare data at two different swings hung from different lengths of rope.

At the first swing, pull the seated person back to a *displacement* of three steps. Release and carefully time five cycles. Remember the time.

Next, find another swing with a different rope length. The rope length should be at least three or four feet shorter or longer than the first swing. Have the same person sit on the swing and pull them back to the same *displacement* as with the first swing. Release and time five cycles.

How does the time for this second swing compare to the time for the first swing? Is the difference significant? So, does a change in the length of the pendulum rope cause the time you recorded to change? Galileo concluded that the length of the rope of a pendulum does affect the time for the pendulum to complete a cycle: the longer the rope, the longer the period.