Understanding Acceleration vs. Time with Pendulums Day 1

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Introduction

In this lab we will build a simple pendulum with our phone as the mass. We will then use the Science Journal app to record *acceleration* as the pendulum oscillates. These recordings will be used to analyze different aspect of the pendulum, such as its period of oscillation.

Additionally, we will analyze the effect of changing the length of the pendulum.

Materials

- An Android or Apple smart phone with the *Science Journal* app installed
- String
- A plastic bag, large enough to hold your phone securely
- A wooden dowel
- A ruler/meter stick

Setup

1. First, form *groups of* 3 to work with.
2. Next, insert a phone into a plastic bag.
3. Poke a hole through the plastic bag and tie one end of the string to the plastic bag through the hole.
4. Tie the other end of the string around the center of your wooden dowel, such that the length of the string from the dowel to the phone is the desired length l.
5. Position the dowel between two desks (or over the edge of only one desk). The setup should look like the figure below.

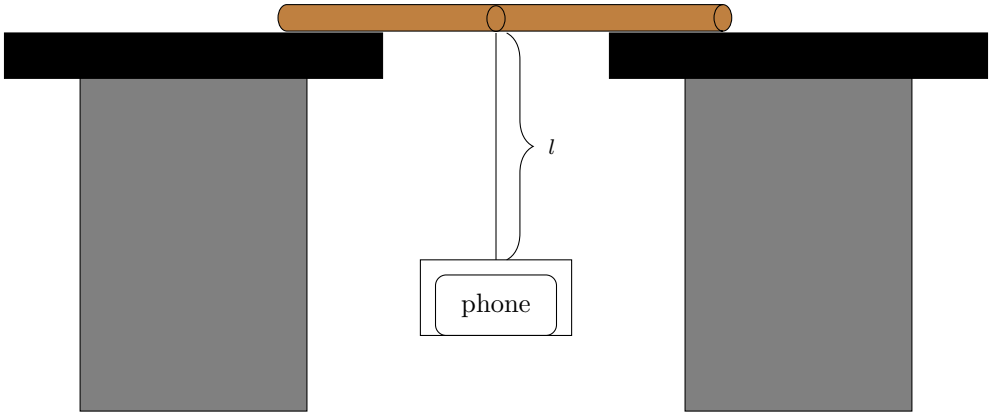


Figure 1: The initial setup.

Procedure

After setting everything up as shown above, open the science journal app on the phone being used (you should be able to use the touch screen through the bag). Begin a new experiment and following the steps below to begin recording acceleration in the x direction.

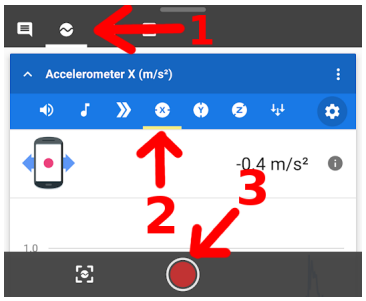


Figure 2: How to start recording

Once you begin recording, lift the phone so that, when released, it will swing in an arc. Make sure you lift the phone so that the screen is pointing up.

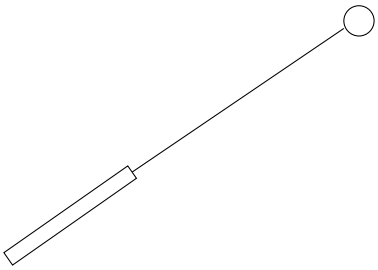


Figure 3: How to begin the pendulum

Release the phone and let the pendulum oscillate several times. Afterwards, stop the recording and observe the recorded data. We are looking for something cyclic, such as

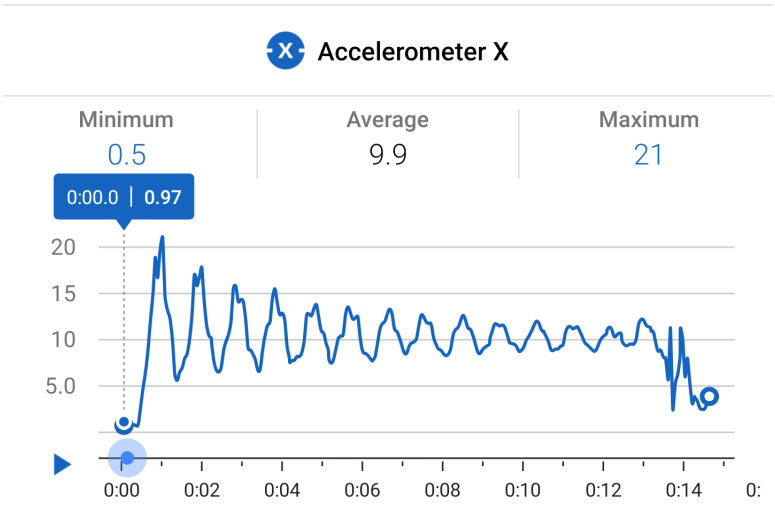
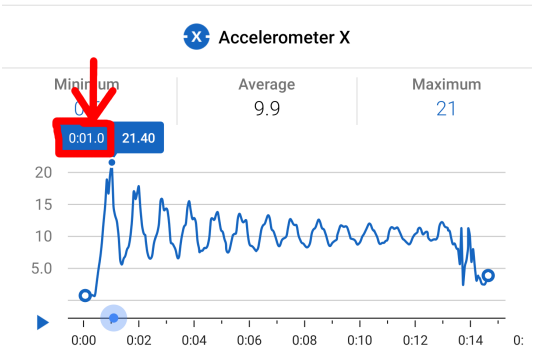


Figure 4: How to start recording

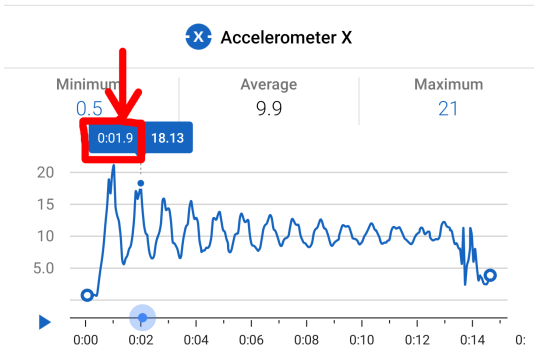
When you are done with your recordings, make sure to save the experiments on the *Science Journal* app!

Calculating The Period

The period is how long it takes to complete one complete cycle. We can calculate it using the app by taking the difference in time between two peaks.



(a) Peak 1



(b) Peak 2

$$\text{Period} = T = 1.9\text{s} - 1.0\text{s} = 0.9\text{s} \tag{1}$$

Questions

We will discuss these questions tomorrow 🙂. Make sure you do enough trials to think about the answers at home!

1. When the phone is first released, is the acceleration at a *maximum* or *minimum*? Why?
2. What happens when the phone is at the bottom of its swing?

3. From the graph, calculate the period of the pendulum swing (how long it takes to complete one full cycle).
4. Try releasing the phone from different starting angles; does the period change? Why or why not?

Data

Something we have control over is how long we make the string. Now that we understand the setup and procedure, go ahead and calculate the period of the pendulum with different lengths! What happens when the length is doubled? What happens when the length is multiplied by 4?

length	trial 1 period	trial period 2	trial period 3	average period

Make a plot of average period vs. length. What kind of relationship do you see?