

Katherine Aho
NSF GK-12 Vibes and Waves in Action
Honors and CP Physics
Lesson 13: Calculate the period of a pendulum

Summary of the lesson

Students were asked to write a program that modeled a simple pendulum. An demonstration of pendulums of different lengths was given at the beginning of the class. The period of the pendulums were timed for each of the different lengths, so that students could see that length is one of the factors that a pendulum depends on. The program contained two objectives: in the first case, an array of pendulum lengths was created and then the period was calculated. A plot of period vs length was made. In the second part, a prompt was added to ask the user for the length and the period would then be calculated for the given length.

Honors and CP Physics Lesson Plan

Text: Conceptual Physics, Paul G. Hewitt

Chapter: Ch 25- Vibration and Waves (Section 25.1)

Objectives: Write a program in R to calculate the period of a simple pendulum

Essential Question: What factors does the pendulum depend on?

Frameworks: SIS1, SIS2, SIS3, SIS4

L-Side Activities: Teacher	R-Side Notes: Students
<p>At the Bell: Demonstrate three pendulums of three different lengths, with the same mass. Show the students how to count one period. Ask the students about they observe about the periods of the pendulum.</p> <p>Agenda: 1. Write the pendulum program. 2. Debug the program 3. Test the results</p> <p>Working It Out:</p> <ol style="list-style-type: none">1. Rank the pendulums (by length) in order from shortest period to longest period.2. What type of relationship is there between length and period?3. What other factors affect the period of the pendulum?4. How do your results differ when you use an array of length values and when you use the single input value from the prompt?5. Compare the results of your program against lab data (if any).6. What are pendulums used for? <p>Class Activity: Use R to calculate values of T (the period) for different lengths ranging from .20 m to 1.0 m in .05 meter increments. Create a graph of the T (y-axis) vs. L (x-axis). Modify the code to prompt you to enter a value for the length (in meters). The program should calculate the period and display the result in the Console.</p> <p>Homework: None</p>	<ol style="list-style-type: none">I. Gravity and length affect the period of the pendulum.II. The longer the pendulum, the longer the period.

R Coding Activity #4

Name:

NOTE: You are creating two different files for today's assignments. Make sure you save and send both to me.

Introduction

The period of a pendulum (T) is the time it takes to swing back and forth. This depends only on its length and the acceleration due to gravity. Remember, pi is approximately 3.14 and $g = 9.8 \text{ m/s}^2$.

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Objective #1: Use R to calculate values of T (the period) for different lengths ranging from .20 m to 1.0 m in .05 meter increments. Create a graph of the T (y-axis) vs. L (x-axis).

Requirements:

- the input must use the correct set of values and the formula must correctly generate the output
- use comments in several places throughout the code
- graph should display a blue line and label your graph with an appropriate title, x-axis label with units and y-axis label with units

To get started...

Step #1: Open **R Studio** (found in the Applications folder or use Launchpad).

Step #2: Start a new file by selecting **File > New > R Script**

Step #3: In the script box (top left), type a comment that explains what this program will do.

Use the objective above as a guide.

Step #4: Type the code that will meet the objective above. Refer to the cheat sheet as needed.

Step #5: Save this file as `R41_lastname`.

Before you begin Objective #2, save another version of this program and use it as a starting point. Save the new file as `R42_lastname`.

Rubric for Objective #1

Expectation	3	2	1	0
A minimum of three comments is used within the code.	More than three comments are used.	A minimum of three comments is used.	One or two comments are used.	No comments are used.
Code correctly utilizes the sequence command to establish the proper range of values.			Yes	No
Code correctly calculates the period (input and output).		Equation used in program correctly calculates period.	Equation has an error but exists in program.	There is no calculation performed.
Graph must display a blue line	Blue line is used in graph.	Line is present, but color not specified.	Graph exists but does not show a line (e.g. data points instead)	No graph created.
Graph includes an appropriate title, x- and y-axis labels with units.	All requirements are met.	Title exists and axes have either labels or units, but not both.	No title and axes lack either labels or units.	Title and axis labels/units are missing.
Total Points	10			

Objective #2: Modify the code you created to have the program prompt you to enter a value for the length (in meters). The program should calculate the period and display the result in the Console.

Requirements:

- No graph is needed for this part.
- You will use the following commands for this part: `print` and `readline`.

- The following code is used to prompt the user for input. You should change what appears in the quotes so the user understands what they need to enter. Be as brief but as specific as possible.

```
L <- readline(prompt="Whatever is in quotes will appear: ")
L <- as.numeric(L)
```

- The output (print) clearly states what the results are (not just a number) and includes units.
For example, if you were calculating the answers to the quadratic formula, the output might read `The solutions to the quadratic equation are 2, -4.` The cheat sheet has an alternative command called `cat` that you may use.

```
print("Whatever is in quotes will appear: ")
print(x)
```

Rubric for Objective #2

3 = exceeds standard	_____	The input prompt is brief and descriptive.
2 = meets standard	_____	The output meets requirements above.
1 = falls short of standard		/4
0 = no evidence	_____	

EMail or AirDrop both files to me before the end of the period.