

PHYS 1401 – General Physics I
Laboratory # 11
Simple Harmonic Motion

INTRODUCTION

In this experiment we shall investigate two different types of simple harmonic motion: The motion of a weight on a spring, and the motion of a pendulum. We shall focus on the factors that determine the period of motion of an oscillating spring, and the period and maximum velocity of a pendulum bob.

Part 1: The Period of a Mass on a Spring

In class, we decided that the variables that could influence the period of oscillation of a mass on a spring are as follows:

- The size of the mass
- The spring constant of the spring
- The amplitude, or how far you stretch the spring before releasing it, called the amplitude

We shall determine experimentally which of these variables determine the period of motion. Begin with mass. Select one of the springs and hang it from the stand. Now select one of the hooked masses – one of the heaviest is best – and hang it from the spring. Take careful note of how the mass stretches the spring once you stop it from moving. Stretch the spring 10 centimeters from this starting position and let it go. Use the stopwatch to time how long it takes for 20 cycles of the mass. Remember that a cycle is one complete trip for the mass.

Question 1: How can you determine the period of the oscillating mass from this measurement?

Record both the mass and the period. Repeat for at least three masses. Create a table containing this information.

Question 2: What things must you keep constant in order to test the theory that changing the mass will change the period? Remember to keep those things constant!

Next, we will check the dependence on spring constant. Notice that you have three different springs, each with a different spring constant.

Question 3: Describe in a series of sentences how you would determine if spring constant has an effect on period. What two quantities must you keep constant for all three springs?

Create a little table with the periods for the three springs.

Question 4: Describe in a series of sentences how you would determine if amplitude has an effect on period. What two quantities must you be careful to keep constant for all trials?

Do five trials to determine if amplitude has an effect on period. Make another little table with your amplitude and period values.

Question 5: What variables have an influence on the period of oscillation of a mass on a spring? Justify your answers with numbers.

Part 2: The Period of a Pendulum

Now we shall investigate the period of a pendulum. In class, we predicted that the following would influence the period of motion of a pendulum:

- The mass of the pendulum bob
- The length of the string
- The starting distance from the “rest position”

This last quantity can also be expressed as a height or as an angle. With our equipment, it is probably easiest to express the variable as a distance from the center.

Question 6: What is your “plan of action” for determining which of these quantities influences the period? Describe the plan in a series of sentences.

Question 7: Which variables have an influence on the period of oscillation of a pendulum? Justify your answers with numbers and tables.

Part 3: The Speed of a Pendulum

Question 8: At which point in a pendulum's "trip" is it traveling the fastest? Justify your answer in terms of the forces acting on the pendulum, and the accelerations those forces cause.

Using a photogate, we can now determine how fast the pendulum is traveling at the "bottom" of its motion. Test the equipment to make sure that you can get a consistent reading of that velocity for a sample pendulum. The three variables from part 2 might also influence the velocity of the pendulum at the bottom of its swing. Outline a plan of action to determine what variables actually influence this velocity. Your plan should include three trials for each potentially important factor. Summarize your plan in a series of sentences, and present your findings in a series of tables.

Question 9: Which variables have an influence on the maximum velocity of a pendulum? Justify your answers with numbers and tables.

Question 10: Discuss the similarities and differences between the two types of oscillator, in terms of the factors that influence their motion.

Materials List

Three springs
Support stand
Variety of hooked masses
Meterstick
Three pendulum bobs and string
Protractor
Photogate