

[Your name and names of collaborators]

Lab: Simple Harmonic Motion of a Mass on a Spring

Learning Objective:

- Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties. [LO 3.B.3.1, SP 6.4, SP 7.2]
- Design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force. [LO 3.B.3.2, SP 4.2]
- Analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown. [LO 3.B.3.3, SP 2.2, SP 5.1]
- Construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. [LO 3.B.3.4, SP 2.2, SP 6.2]

Materials:

spring with variable **mass**, timer, ruler, triple beam balance

Purpose

Determine the spring constant of a spring using two different methods: stationary masses and oscillating mass. Qualitatively and quantitatively describe the simple harmonic motion of a mass on a spring using mathematical and graphical data analysis.

Assumptions(hypotheses)

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$F = -kX$$

in which T is period in seconds, m is mass in kg, and k is spring constant (sometimes referred to as force constant or proportionality constant)

System is frictionless. Spring is massless. Amplitude (displacements) are relatively small.

Procedure

State exactly what you are doing, what tools you are using, and **why** you are doing it in complete sentences from the 3rd person perspective. Explicitly state the control and variables in each experiment.

Data

Labeled tables, include units in column headers.

Analysis

MATHEMATICAL: Include calculation for spring constant from stationary mass experiment.

Include calculation for spring constant from oscillating mass experiment.

Include percent error calculation between stationary and oscillating mass derived spring constants.

GRAPHICAL: Include graph with a slope that represents the spring constant from the stationary mass experiment. Include graph with a slope that represents the spring constant from the oscillating mass experiment. Include graph of position v. time from motion detector.

Include percent error between graphically derived spring constants.

Conclusion

Construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. In order to do so successfully, apply **explicit** mathematical and graphical analysis. What is the relationship between F and x ? between T and m ? Based on motion detector graph, describe changes in position, velocity, and acceleration over a single cycle. Relate these changes to the energy transformations of the system. *Ex. The velocity of the system is at a maximum when the mass is at its equilibrium position. Therefore, kinetic energy is at a maximum and elastic potential energy is at a minimum. Gravitational potential energy is at*

Sources of Uncertainty(error)

Include quantitative and qualitative error analysis to compare the k constants. Define and explain the accuracy and precision of the procedure, data collection, and ways to improve these things. Avoid blanket statements such as "human error." IF for some reason you absolutely must address your systematic errors, explicitly state how your incompetence affected your data collection and your results. For example, show how over measuring distance decreased your theoretical mass, thus increasing your percent error. It is encouraged to address systematic errors of the lab set up, the equipment, and the assumptions. For example, in a conservation of energy lab, it would be wise to address the loss of energy as thermal energy. It is encouraged to address and define random error. Reference this document from College Board in order to make these distinctions between types of error and to become a better human being: <http://goo.gl/5WSVID>

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