FLIPPING A LAB

AN INQUIRY TO DETERMINE UNEXPECTED CHALLENGES

LAB 1: SPRINGS AND SIMPLE HARMONIC MOTION

Prior to the Lab, the class had done calculations which required them to

a) Determine the spring constant

b) Analyze a system undergoing Simple Harmonic Motion

--approximately 3 ¾ hrs. of contact time spent in lecture/ recitation format.

TASK

Design a Lab that will determine the spring constant using two different techniques—one involving Simple Harmonic Motion and the other one of your choosing.

RESPONSE TO DESIGN YOUR OWN LAB?

AFTER SOME GRUMBLING…THEY GOT TO WORK

VERSION 1

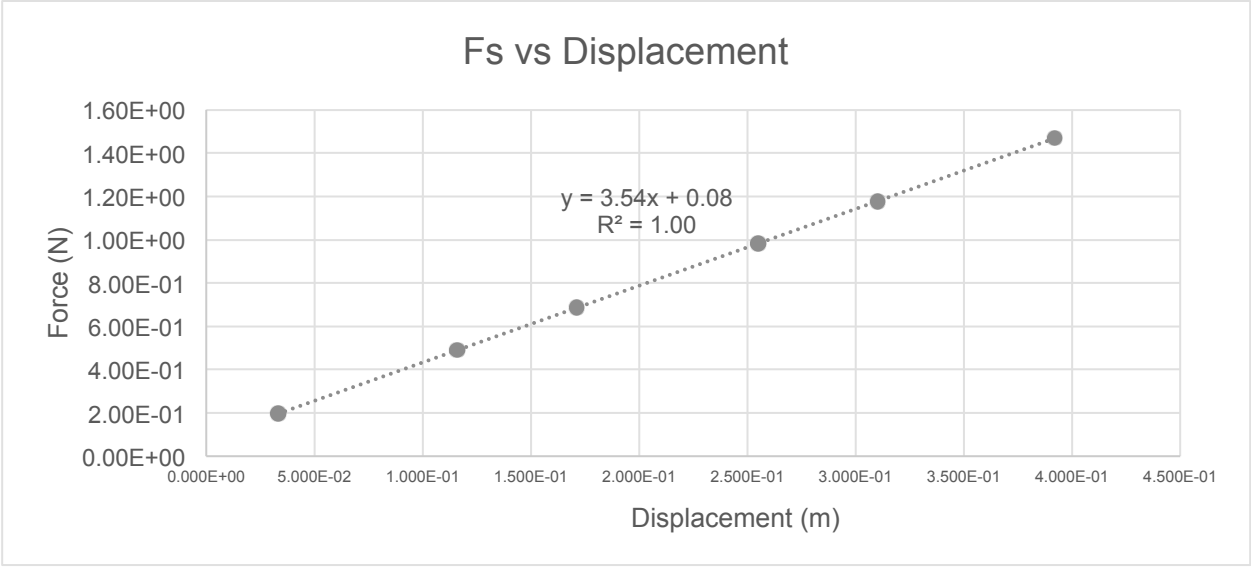
- Hang 5-6 masses from a vertical spring and measure the resulting displacement from equilibrium
- Challenge—no meter sticks in the stockroom!
- Solution—Use LabPro to measure position with the motion detector probe

ANALYSIS

- **Find average of the spring constants determined from mechanical equilibrium**
  - Suggested they plot their data with Force vs displacement
  - --a few data sets had an “outlier”
- **Suggested that instead they find the slope of the best fitting line through their data to determine the spring constant k**

VALUES FOUND

- **Group 1: k1 = 3.54 N/m**
- **Group 2: k1 = 3.57 N/m**
- **Group 3: k1 = 3.31 N/m**
- **Group 4: k1 = 80.8 N/m**



SECOND METHOD

- **Measure period of oscillation about equilibrium point**
  - Approximately 10 minutes left during class period
  - Did 1 measurement of motion, captured by LabPro and time measured by stopwatch (phone) for 10 cycles
  - Used ideal spring model to find k
  - $T=2\pi\sqrt{m/k}$
- **Hit or miss—half the lab groups had inconsistent k values between the two methods**
- **Tasking: How could we improve upon this second method? Read the chapter to see what effect, if any, the mass of the spring might have.**

MODIFICATION

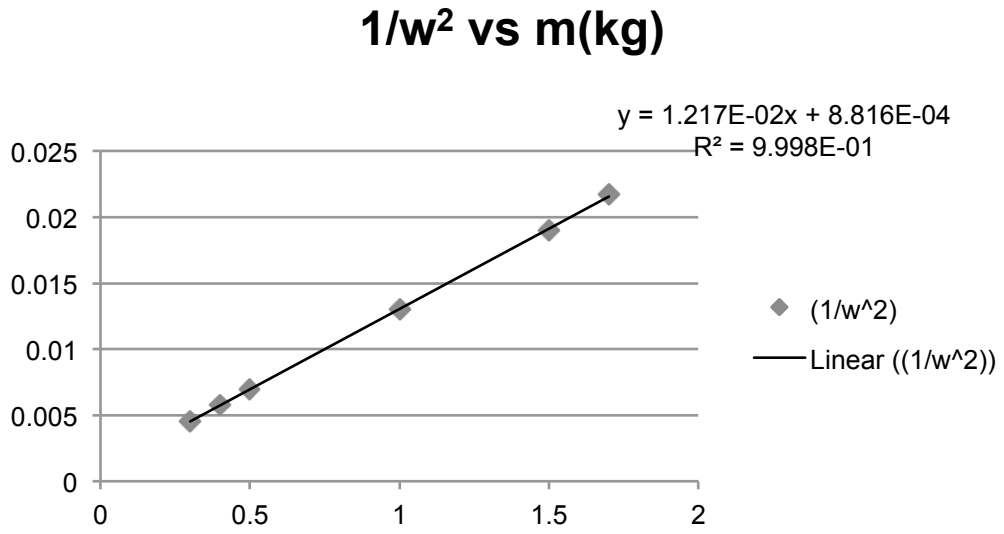
- **Use Decaying SHM to curve-fit data from LabPro**
- **Use 5 to 6 mass measurements vice a single mass.**
- **Determine what effect the spring mass might have**
  - Y(t) = Y + A*exp(-1*B*t)*cos(w*t+d)
  - $T=2\pi\sqrt{m+C*m_s/k}$
- **Plot T^2 versus mass m and determine slope of best fitting line and the "y"-intercept**
- $T^2=(4\pi^2/k)m+(4\pi^2/k)m_s C$
- $1/\omega^2=1/k\,m+1/k\,m_s C$—**equivalent using LabPro Data**

VALUES FOUND ($1/W^2$ VS M)

- Group 1: k1 = 3.54 N/m; k3 = 3.66 N/m; %D = 3.3%
- Group 2: k1 = 3.57 N/m; k3 = 3.57 N/m; %D = 0%
- Group 3: k1 = 3.31 N/m; k3 = 3.30 N/m; %D = .3%
- Group 4: k1 = 80.8 N/m; k3 = 82.2 N/m; %D = 1.7%

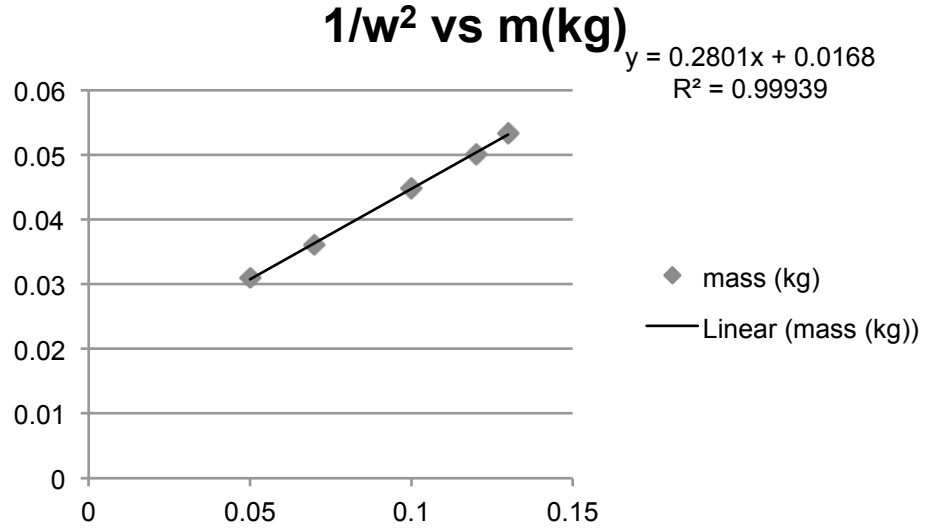
But the Values for C was not around .3

Values were 6.8, 6.6, 6, and 4.5



Group 4, part 3

m_s = 16.0 g



Group 2, part 3

m_s = 9.0 g

Note: 1 outlier removed

DISCUSSION

- **What I thought was obvious, wasn't to the students**
- **The students came up with a method that I wasn't expecting**
- **Values for the constant C did not reflect the text statement that is value is 1/3**
  - Causes?