Masses and Springs

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General Physics Lab – PHYS 211 L – 01

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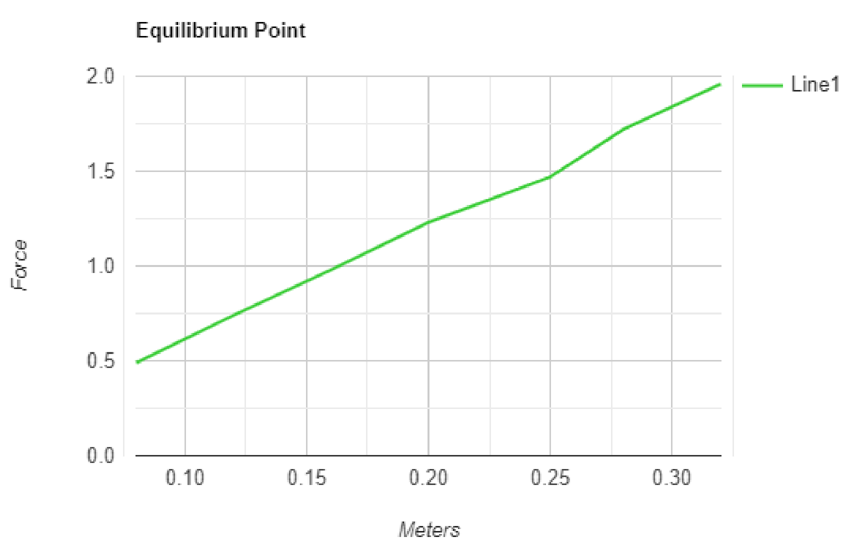
Simple harmonic motion is the motion of an object that is subject to a force that is proportional to the object's displacement. An object attached to a spring undergoes simple harmonic motion. The spring constant, k, is a measure of the stiffness of the spring. The quantitative relationship between the spring force and the displacement is known as Hooke's Law. The law is named after British physicists Robert Hooke. Hooke's equation holds in many other situations where an elastic body is deformed, such as wind blowing on a tall building. For this lab, constant k was found using two graphs and data points. A system of masses connected by springs is a classical system with several degrees of freedom.

Data Presentation

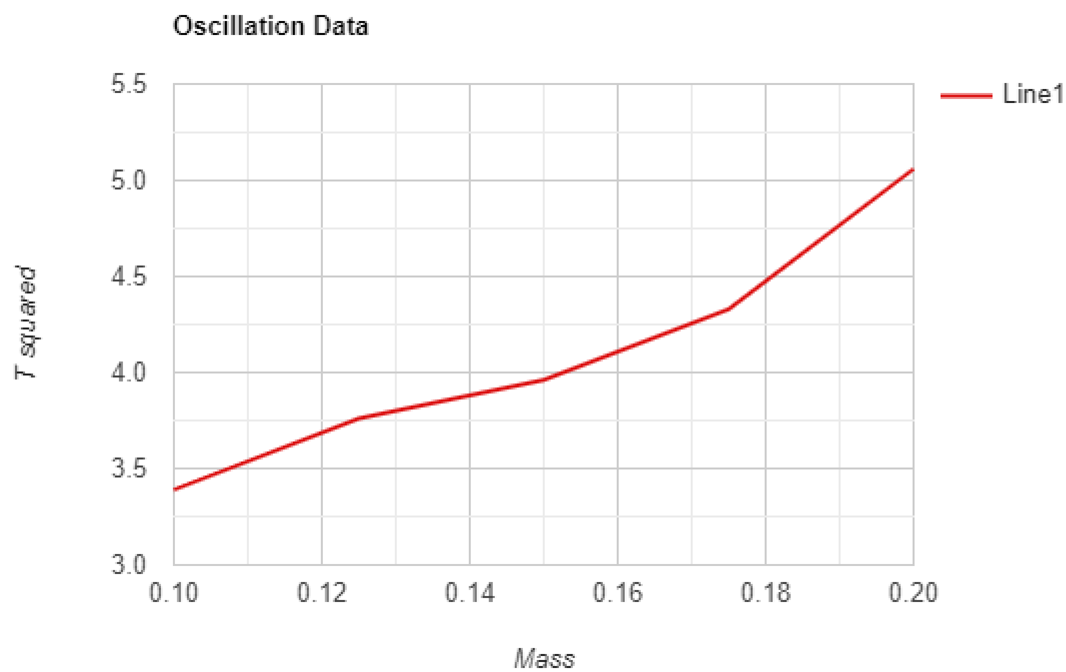
Part A: Equilibrium Point

Added mass (g)	**X_0 (cm)**	**Converted mass (kg)**	**Converted X_0 (m)**	**Force**
50.0	8 cm	0.05	0.08 m	0.49 N
75.0	12 cm	0.075	0.12 m	0.74 N
100.0	16 cm	0.1	0.16 m	0.98 N
125.0	20 cm	0.125	0.20 m	1.23 N
150.0	25 cm	0.150	0.25 m	1.47 N
175.0	28 cm	0.175	0.28 m	1.72 N
200.0	32 cm	0.200	0.32 m	1.96 N



Oscillation Data

Mass(g)	**Average T (s)**	**T^2**
100.0 g	1.84 s	3.39 s
125.0 g	1.94 s	3.76 s
150.0 g	1.99 s	3.96 s
175.0 g	2.08 s	4.33 s
200.0 g	2.25 s	5.06 s



Calculations

For this lab, the objective was to find the constant k after finding the slope of two different sets of data. In Part A, the equilibrium table was filled out, and there were conversions added so that the graph would be in the proper units. To find x0, the correct weight was placed on the spring, and the natural length subtracted the stretched length. This was done until all the weights had been measured. Part A's graph was in meters by force, so to determine the force, each weight was converted to kg and multiplied by g, which is equal to 9.80 m/s. Then once the data points were found, a graph was created, which is labeled Equilibrium Point. Following this, the slope of the line was found by taking two data points and using y2-y1/x2-x1. The two points used to find the slope was 1.96-1.72/0.32-0.28. The slope was determined to be 6. Using the equation 4π2/6 gave the constant k, 6.58. In Part B, the table was called oscillation, and the period was determined. The weights were placed on the spring, and the timer was used to find the period. After the time was gathered for each weight, a line graph was created, displayed in the graph called Oscillation Data. The mass was converted to kg. Then the slope was found using two data points 3.96-3.76/0.150-0.125=8. The next step was to use the percent error on the constant k's recovered. $\frac{|6-8|}{6}*100 =$ 33.3% error.

Unstretched length is where the spring is naturally without having any tension or compression against it. The resting position is the equilibrium position. If a spring is compressed, then a force with a magnitude proportional to the decrease in length from the equilibrium length pushes each end away from the other. Stretching a spring will make the force with volume proportional to the increase in size from the equilibrium length is pulling each end towards the other. The relationship of the applied force F and the displacement x of spring has the general form F = kx, where the constant k is called the spring constant and is a measure of the "stiffness." The period is the time it takes from one side to the other and back. A way to measure it would be to count using a stopwatch or use the period equation $T=2\pi$. Therefore, oscillation is directly proportional to the mass and inversely proportional to the spring constant. A stiffer spring with a continuous mass decreases the period of change. Increasing the mass increases the period of oscillation. Increasing the spring strength can give a more massive mass a shorter period than a lighter mass. Image 1,2 and 3 show the gravitation and spring forces at three different points throughout oscillation. Picture 1 is when the mass is at the lowest point, Image 2 shows the mass at equilibrium, and Image 3 shows the mass close to the spring's natural length.

Image 1

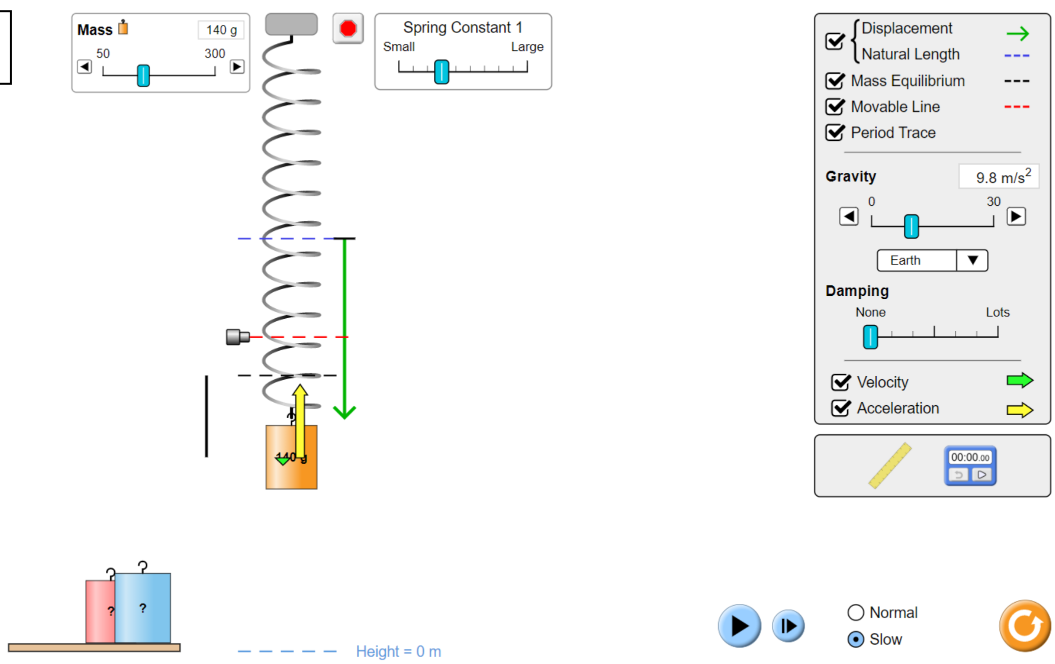


Image 2

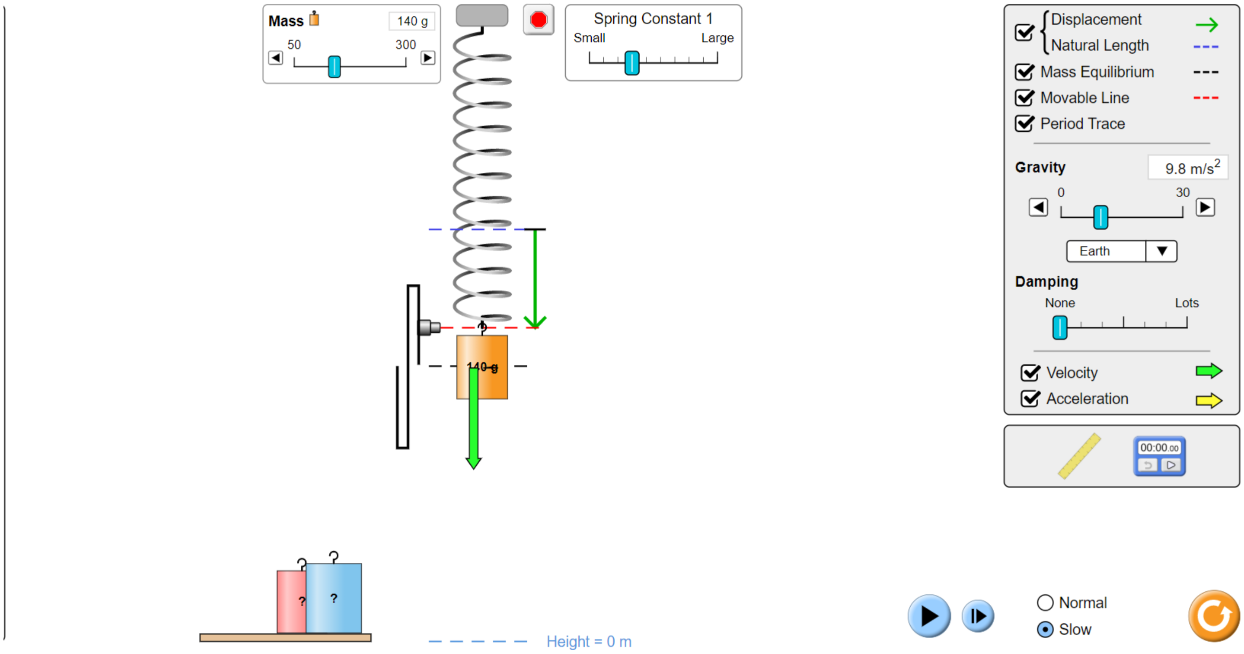
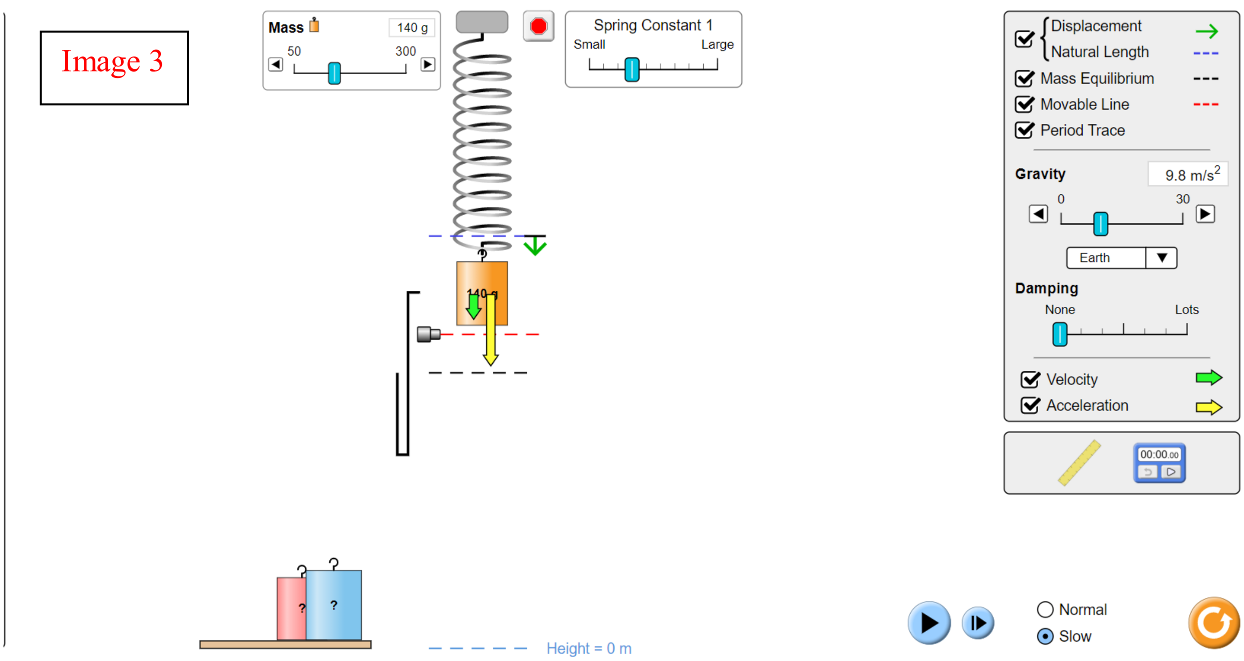


Image 3



When the spring compresses, speed decreases, and when the spring elongates, the velocity increases. When the spring elongates, acceleration is in an upward direction, and when the spring compresses, the acceleration is in a downward motion. Kinetic energy increases as the weight are at the mass equilibrium when the weight is halfway through the oscillation and decreases when the weight leaves the balance. It has zero energy when the gravitational potential energy or elastic potential energy is maximized. Gravitational potential energy increases when the spring compresses and decreases when the spring elongates. It never has zero energy. Elastic potential energy increases when the spring elongates, which is its maximum point, and decreases when the spring compresses it has zero energy when PE_{grav} is maximized. In correlation to the Energy Graph, when the weight is in a downward motion elongating the spring, speed is maximized. To determine the mystery masses' mass, you need to know the constant K and the change in length. This gives you the force, then you divide the force by g and find the masses. The mass of the purple mystery weight is about 70 g.

Conclusion

In conclusion, this experiment was designed to allow the user to gain more knowledge and better understand different ways to find constant k. Force/meters give constant k. The spring constant, k, is a measure of the stiffness of the spring. It is different for different springs and materials. The larger the spring constant, the stiffer the spring, and the more difficult it is to stretch. Using the data points from Part A and B yielded a constant k of 6 and 8. The percent error equation showed a 33.3% error. There could have been many variables that cause the error to be so large. One mistake could have been the time count in Part B. The only way to see if this was the problem would be to redo the lab to get better results. Following the experiment, even though the results were not close, there is a better understanding of how to solve for constant k and the different tools that can be utilized.