

Hooke's Law & the Conservation of Energy

Physics Lab

Name:

Polly Williams

Partners:

OBJECTIVE:

You should be able to verify the law of conservation of energy in an oscillating spring.

BACKGROUND:

Just like a pendulum, a mass on a spring will "oscillate" or move in a periodic motion up and down. The mass will move about a midpoint where the tension in the spring is equal to the force of gravity on the mass. At the top of the oscillation, the mass has maximum gravitational potential energy, because the tension in the spring is reduced. At the bottom of the oscillation, the spring has maximum elastic potential energy due to the tension placed on it.

Hooke's law states that the force in a spring at any point in time can be calculated by:

$$F = kd \quad \text{where } k \text{ is the spring constant, and } d \text{ is the elongation.}$$

The energy or work a spring can perform is calculated by $W = \frac{1}{2} F d$, so substituting Hooke's law into this yields:

$$W = \frac{1}{2} k d^2.$$

In this experiment we will compare these two forms of potential energy as well as test the law of conservation of energy.

EQUIPMENT:

**** See Set-up diagram at the END of the lab! ****

Hooke's law apparatus, Set of slotted masses, Tape

PROCEDURE:

Part 1: Calculating k, the spring constant: Record all answers in the data table!

1. Adjust the scale or mass pan (holder) to read 0.0 cm at the **bottom** of the pan.
2. Place masses on the pan until it deflects approximately $\frac{1}{4}$ of the full scale. Record this elongation and mass in the data table.
3. Repeat this procedure 5 more times with any elongation or mass until you have reached full scale deflection. Record all masses and elongations.

CALCULATIONS (for Part 1): Record all answers in the table!

4. Calculate the amount of force on your pan.
5. Find the spring constant, k, using Hooke's law, $F = kd$.
6. Find the average of your elastic constants and record. This is what you will use in the next section for your spring constant, k.

Part 2: Conservation of Energy: Record all answers in the data table!

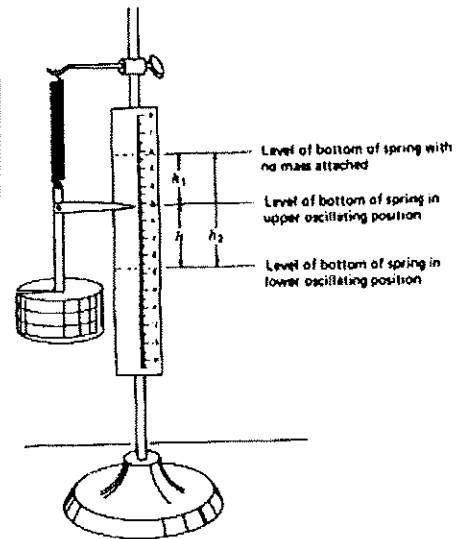
1. Place a mass on the pan so that the spring is stretched about $\frac{1}{2}$ full scale. Record the mass in data table 2.
2. Raise the mass so that the bottom of the pan is between the zero mark and this new position. Let the pan drop.
3. Allow the mass to oscillate a few times, and then record the highest (h_1) and lowest (h_2) points on the scale that the mass reaches. See diagram.
4. Run several more times varying the mass and height of oscillation.

CALCULATIONS (for Part 2): Record all in data table in the tables.

- Find h , the difference between the highest and lowest points. $h = |h_2 - h_1|$
- Find the elastic potential energy in the spring using $W = \frac{1}{2} k (h_2^2 - h_1^2)$. (k is your average spring constant from the above calculations.)
- Calculate the gravitational potential energy using $PE_g = m g h$.
- Find the percent error between the Gravitational and Elastic potential energies. Use Gravitational PE as the accepted value.

DATA: Part 1 -- Finding the spring constant, k .

Trial #	Mass (kg)	Elongation (m)	Force (N)	Spring Con., k (N/m)
1	.02 kg	.013 m	.196 N	15.7 n/m
2	.04 kg	.029 m	.392 N	13.52 n/m
3	.06 kg	.041 m	.588 N	14.34 n/m
4	.08 kg	.058 m	.784 N	13.52 n/m
5	.1 kg	.075 m	.98 N	13.07 n/m
6	.12 kg	.089 m	1.176 N	13.21 n/m
Average $k =$				13.89 n/m



DATA: Part 2 -- Conservation of Energy

Trial#	Mass (kg)	h_2 (m)	h_1 (m)	h (m)	Elastic PE (J)	Grav. PE (J)	% Error
1	.06 kg	.045 m	.023	.022 m	.024 J	.013	7.97
2	.08 kg	.065 m	.035	.03 m	.037	.024	34.7
3	.1 kg	.076 m	.048	.028 m	.056	.027	34.7
4	.12 kg	.090 m	.064	.026 m	.042	.042	49.7

QUESTIONS:

- What is the relationship between the amount of mass on the pan, and the rate of its oscillation? Describe WHY this relationship might exist.

The more the mass the longer the oscillation the more mass there is the further the weights will go down so it will take longer to return to original pos.

- What might have caused the error between the potential energies? Give at least 3 reasons.

Not enough added energy
Miss reading scale
Incorrect corrections