Physics Lab

Lab # _____

*Name:*____*Date:*________________*Period:*_____

Elastic Potential Energy in a Spring
(Hooke's Law Revisited)

<u>Introduction:</u> You should recall from a previous lab exercise, that the force per unit of length needed to stretch a spring is referred to as the <u>Spring Constant</u> and the principle of Physics that describes the behavior of springs is called <u>Hooke's Law</u>. If a force causes an object to move in the same direction as the force, then work is done. Work requires a change in <u>potential energy</u>. The ***"elastic potential energy"*** stored in a spring is related to the spring constant but is not the same thing.

<u>Objective</u>**:** In this experiment you will determine the amount of <u>elastic potential energy</u> stored in a spring.

<u>Materials:</u> Springs Masses Ring Stand Ruler Calculator

<u>Procedure:</u>

Part I This part of the procedure is the same as the procedure for the "Hooke's Law" lab, so ***you already have the necessary data***. Refresh your memory and take note of the "caution" statement.

1.) Measure the length of the spring with 0 added mass. Record this length in the data table.

2.) Hang a mass on the spring. Calculate and record the force (weight) of the mass.

*3.) Measure and record the distance the spring is ***<u>stretched</u>*** (the ***<u>change</u>*** in length).

4.) Repeat steps 2 & 3 with various masses.

5.) Graph your results. Determine the slope of your graph. The <u>slope</u> = the "<u>spring constant.</u>"

Caution:

1. In order to complete Part II, all lengths must be converted from ***centimeters*** to ***<u>meters</u>***.

2. You must use the distance the spring is ***<u>stretched</u>*** (the ***<u>change</u>*** in length) not the entire length.

3. The spring constants must also be changed from ***N/cm*** to ***N/m.***

(There must be a quick way to do this without having to re-graph!)

Part I Data Tables

Added Mass (grams)	(Y value) *Weight (Force) (Newtons)*	*Length of Spring (m)*	(X value) *Change of Spring Length (m)*
0	***0***		***0***

Spring# ___________

Slope = __________

Spring Constant = __________

Added Mass (grams)	(Y value) *Weight (Force) (Newtons)*	*Length of Spring (m)*	(X value) *Change of Spring Length (m)*
0	***0***		***0***

Spring# ___________

Slope = __________

Spring Constant = __________

Added Mass (grams)	(Y value) *Weight (Force) (Newtons)*	*Length of Spring (m)*	(X value) *Change of Spring Length (m)*
0	***0***		***0***

Spring# ___________

Slope = __________

Spring Constant = __________

Part II Work and Potential Energy:

Introduction:

When a force is applied over a distance, Work is done in the same direction as the applied force. This relationship can be expressed as:

Work = (Force)(Distance) or W = Fx

In the case of a spring, the applied force increases from $F_s = 0$ (unstretched) to $F_s = kx$ (stretched).

So, the ***average*** applied force over the distance x is $(0 + kx)/2$ or:

$\bar{F}_s = \frac{1}{2} kx$. ($\bar{F}_s$ = ***average*** force)

Substituting into the work equation, the result is:

$$W = Fx$$

$$W_s = \bar{F}_s x$$

$$W_s = (\tfrac{1}{2} kx)\, x$$

$$W_s = \tfrac{1}{2} kx^2$$

Work has been defined as a change in Potential Energy. Therefore, the work done stretching a spring must be equal to the change in the potential energy stored in the spring, called the ***Elastic Potential Energy*** of the spring. Making another substitution:

$$PE_s = W_s$$

$PE_s = \frac{1}{2} kx^2$ ***k = spring constant*** ***x = change in length***

Procedure:

1. Go back to your data for the springs that you measured and calculate the work and elastic potential energy for each spring. Record your data on the Part II Data Tables.

2. Graph the ***Elastic Potential Energy*** as a function of ***Change in Length*** for each of the springs. Graph by hand but also use EXCEL with a 2^{nd} order polynomial "best fit."

Caution:

1. Work and Potential Energy are expressed in ***Joules*** or ***(Newtons)(Meters)*** so be sure to convert ***centimeters*** to ***meters*** before you calculate work and PE.

2. The spring constants must also be changed from ***N/cm*** to ***N/m.***

Part II Data Tables

$*F_{avg} = ½(Weight)$

$W_s = F_{avg} x$ | **$PE_s = ½ kx^2$**

Weight (Force) (Newtons)	**Average Force (Newtons)*	*Change of Spring Length (m)*	*Work (Joules)*	*Elastic Potential Energy (Joules)*
0	***0***	***0***	***0***	***0***

Spring# __________

Spring Constant = _________

Weight (Force) (Newtons)	**Average Force (Newtons)*	*Change of Spring Length (m)*	*Work (Joules)*	*Elastic Potential Energy (Joules*
0	***0***	***0***	***0***	***0***

Spring# __________

Spring Constant = _________

Weight (Force) (Newtons)	**Average Force (Newtons)*	*Change of Spring Length (m)*	*Work (Joules)*	*Elastic Potential Energy (Joules*
0	***0***	***0***	***0***	***0***

Spring# __________

Spring Constant = _________