Marble Launcher Lab – Advanced
PSI Physics – Energy

Name______________________

Objective:

- To apply the conservation of energy.
- To use definitions of KE, GPE, and a spring's EPE to test a hypothesis: a spring's $\mathrm{EPE} = \frac{1}{2}\mathrm{kx}^2$.

Description/Background:

In this lab, you are going to use a marble launcher to launch an object into the air at a 90˚ angle. You must first pull the handle of the launcher down, which will give the system EPE, and when you release it, the EPE will be converted into KE, giving the object an initial velocity (v). When the marble reaches the top of its trajectory (h); all of the KE is converted into GPE.

Hypothesis:

When the spring is compressed, it stores energy elastically. You are going to test whether a spring's $\mathrm{EPE} = \frac{1}{2}\mathrm{kx}^2$, where k is the spring constant of the spring, and x is the displacement of the spring from its rest position.

Materials:

- Marble Launcher
- 10 or 20 g ball bearing or marble
- Meter Stick
- Scale to measure the mass of the marble(or other object)

Procedure:

Note: all data collection and analysis tables are on the last page of this handout.

1. Measure the mass of the object and *record this in the 3rd column of the Data Analysis Table at the back of this handout*.
2. Hold the meter stick vertically on the table ready to measure the maximum height of the marble (h).
3. Place the handle of the launcher into one of the first 3 notches. Practice launching the marble a few times (2 or 3) and practice measuring the maximum height using the meter stick.

For each of the 3 notches on the launcher, repeat the following 3 times:

4. Release the handle and measure the height (h) the object goes. Record which notch you used and h in the Data Collection Tables.

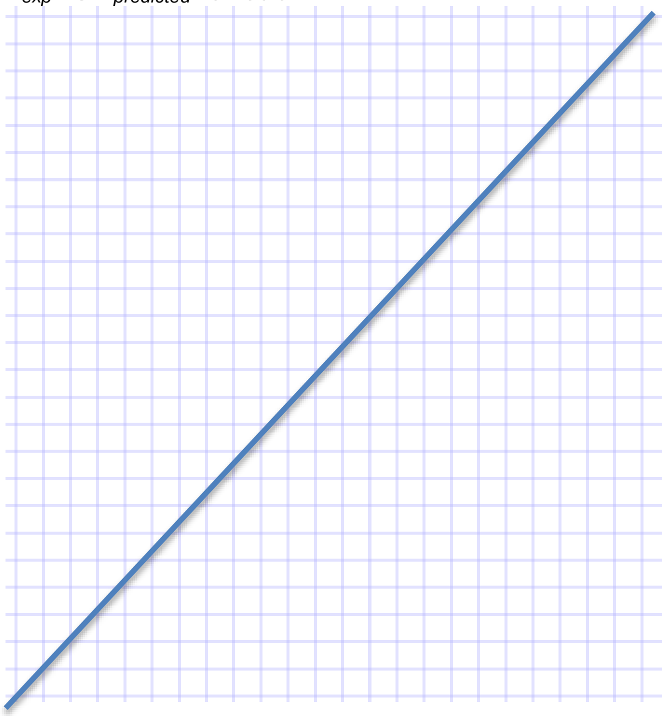
Data Analysis:

1. Calculate average values of h for each value of x and record these in the last row of the appropriate Data Collection Table.
2. Calculate k by following the steps in the *Calculation of k* box

3. Record each notch with its associated average value of h_{exp} into the appropriate place in the *Predicting h* table.
4. Copy the value of m and the calculated k from this box into the adjoining *Predicting h* table
5. Complete the *Predicting h* table to find $h_{predicted}$ for each value of x.

Analysis:

1. For each notch, are your predicted and experimental values of h fairly close or very different from your predicted values of h? You can check this by graphing h_{exp} vs $h_{predicted}$ for each x:



If h_{exp} and $h_{predicted}$ are the same, the will lie on the line with slope 1 on the graph. Do your points follow the line fairly closely, sloping off slightly or close to the line on either side, or are they wildly off?

2. Given the above result, would you say the hypothesis was correct, that a spring's $\mathrm{EPE} = \frac{1}{2}\mathrm{kx}^2$, where k is the spring constant of the spring, and x is the displacement from the top of the launcher to the different notches?

3. Why would the calculated values of for height of the object and the experimental values differ, excluding reasons of faulty measurements and calculations?

Application:

4. A 20 kg boy standing on a diving board is held down 0.5 meters below the horizontal by two of his big friends. When his friends release the board, the boy reaches a maximum height 1 meter above the horizontal. Assuming the board is a spring, what is the spring constant of the board?

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Data Collection Tables

x_1 = cm	
Trial #	h (m)
1	
2	
3	
Average: h_{exp} =	

x_2 = cm	
Trial #	h (m)
1	
2	
3	
Average: h_{exp} =	

x_3 = cm	
Trial #	h (m)
1	
2	
3	
Average: h_{exp} =	

x_4 = cm	
Trial #	h (m)
1	
2	
3	
Average: h_{exp} =	

Calculation of k:

$weight =$_________N (unless you know m)

$m = \frac{weight}{g} =$ __________ kg

$x_1 =$ ____________ cm = ____________ m

$GPE = mgh_{exp}$ = ___________J

$EPE =$ __________ $= \frac{1}{2}kx_1{}^2$

$k = 2 \times EPE/x_1{}^2 =$ ____________

Predicting h:

	x	m	k	$EPE = \frac{1}{2}kx^2$	$GPE = EPE$	$h_{predicted} = GPE/mg$	h_{exp} (average h)
x_1							
x_2							
x_3							
x_4							