Elastic Potential Energy Activity

When a spring is compressed or stretched, it takes work. In other words, energy is put into the spring. We call this energy Elastic Potential Energy. The purpose of today’s activity is to create the equation for the elastic potential energy (Uelas) that a spring has when it is compressed or stretched.

Materials: GLX, Force sensor, spring, masking tape

Procedure:

1. Find a space with lots of room, either out in the hallway or between the tables.
2. Lay out the spring on the floor with the end attached to the force sensor right at the beginning of a square tile. Place a piece of masking tape on the floor at each end of the un-stretched spring.
3. Have 1 person hold one end of the spring that will not move. Attach the force sensor to the other end of the spring.
4. Stretch out the spring to multiple stretch distances, recording the resulting force needed for each location. Record those values.
5. When all data has been collected, remove tape from the floor and return materials to room.

Data:

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| --- | --- |
| Stretch distance (ft) | Force sensor reading (N) |
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What do you notice about the distance stretched compared to the force? What kind of relationship do the two have?

Hop onto a computer and input the data into excel or google sheets. Graph the data. Print out the graph and staple it to this assignment.

What type of relationship does the force from a spring have with the stretch distance?

What is the slope of your trendline? What would the units for this value be?

This value is called the spring constant. It is different for each spring and deals with the molecular bonding of the metal and how the metal is twisted up. Its symbol is k.

Using your graph, and the knowledge that the Work done is F\*Δx, Calculate the work done on the spring for the whole experiment. HINT: What shape is the graph?

If the area under the F vs Displacement graph is the energy of the spring, come up with an equation for the Elastic Potential Energy in terms of k and the stretch distance x.

For you calculus people, the true definition of work is : , so if the spring force is a function of the stretch distance (Fs(x) = kx) what is the equation for the work done by a spring which would be the Uelas?

Post Lab Questions:

1. The figures below show systems containing a block attached to the end of a spring and resting on a frictionless surface. In each system, the springs are stretched by a student to the right by a distance given in the figure. The mass and force constant are also given for each system.



Rank these systems on the basis of the potential energy of the stretched spring-block systems.

Greatest 1 \_\_\_\_\_\_\_ 2 \_\_\_\_\_\_\_ 3 \_\_\_\_\_\_\_ 4 \_\_\_\_\_\_\_ 5 \_\_\_\_\_\_\_ 6 \_\_\_\_\_\_\_ Least

Please explain your reasoning.

1. Same situation as above, but now rank these systems on the basis of the maximum velocity of the stretched spring-block systems.

Greatest 1 \_\_\_\_\_\_\_ 2 \_\_\_\_\_\_\_ 3 \_\_\_\_\_\_\_ 4 \_\_\_\_\_\_\_ 5 \_\_\_\_\_\_\_ 6 \_\_\_\_\_\_\_ Least

Please explain your reasoning.

1. I have a box that is pushed into a spring a distance of A meters and when released it travels a distance of B meters before coming to a stop due to friction. If I grab the box and now compress the spring again to a distance of 2A meters, how far will the box travel now in terms of B?
2. An object of mass M is placed against a spring with spring constant k and pushed back a distance of x, compressing the spring. When released, the object moves forward on a frictionless surface and then hits a ramp. DERIVE an equation for the max height the object travels in terms of m, k, x and any constants.
3. Two blocks are placed on a frictionless ramp and held against a spring that is compressed one-half meter. (The mass of the blocks and force constant of the springs are also given for each system.) The blocks are then released from rest, and the compressed spring causes the blocks to accelerate up the ramp while in contact with the blocks. At the instant shown, the blocks are just about to lose contact with the end of the spring. Three students are discussing how far the blocks will slide up the inclines.



*Andy:* “I think they will both travel up the same distance on the inclines. The kinetic energy at the point shown in the diagram is equal to the initial elastic energy stored in the compressed spring. This is the same for both cases since they both are compressed the same distance and have the same spring constants. The kinetic energy at the point shown is equal to the gravitational potential energy at the top. Since both the kinetic energy and the gravitational potential energy depend on the mass, the mass cancels out leaving the same heights for each case.”

*Badu:* “Since they both have the same energies when they are initially compressing the springs, they have to have the same energy at the top when they stop. So the lighter mass has to go higher. “

*Coen:* “I think the block in Case B will go higher since it has more mass and its momentum should be larger at the point shown since they both have the same initial potential energy.”

Which, if any, of these three students do you agree with?

Andy\_\_\_\_\_ Badu \_\_\_\_\_ Coen \_\_\_\_\_ None of them\_\_\_\_\_\_