Elastic Potential Energy

Any object than can be ***deformed*** (have its shaped changed) and then return to its original shape can store elastic potential energy.

- We're still talking about potential energy, since it is stored energy until the object is allowed to bounce back.
- "Elastic" does not refer to just things like elastic bands…other materials that would be referred to as elastic would be
    - pole vaulter's pole
    - springs
    - cheese (no, I'm just kidding. Just wanted to see if you're paying attention)

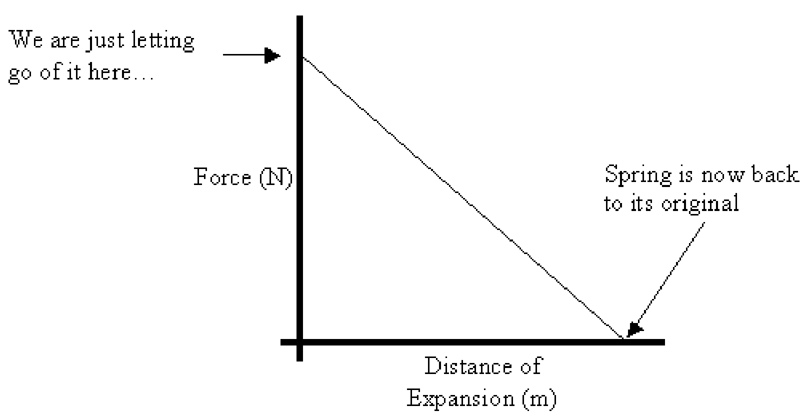
You learned in Physics 20 that Hooke's Law is…

$$F = kx$$

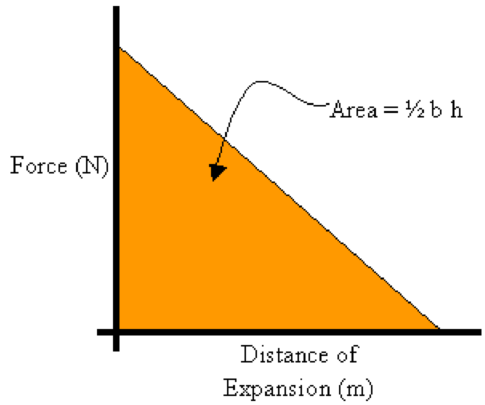
F = force (N)
k = spring constant for that object (N/m)
x = amount of expansion or compression (m)

We can use this formula to figure out a formula for the energy stored in the spring.

- Remember that W = F d
- We might be tempted to just shove the formula for Hooke's Law into this formula to get $W = kxd = kx^2$, but this is wrong!
- You have to take into account that the force is not constant as the object returns to its original shape… it's at a maximum when it is deformed the most, and is zero when the object is not deformed.
- Let's graph Force vs Distance of Expansion for a spring that was stretched and we are now letting go of it…



But this is really just a Force vs Displacement Graph like the ones we just looked at a couple of sections back! To figure out the energy of the spring we can just figure out the work it does by looking at the area under the graph.



$$\text{Area} = \tfrac{1}{2}\,bh$$
$$= \tfrac{1}{2}\,F\,x$$
$$= \tfrac{1}{2}\,(kx)\,x$$
$$\text{Area} = \tfrac{1}{2}\,kx^2 = W$$

So the work done by the spring (and then energy it stored) can be calculated using…

$$E_e = \tfrac{1}{2}\,kx^2$$

E_e = eleastic potential energy (J)
k = spring constant (N/m)
x = amount of expansion or compression [deformation] (m)

Expansions are +
Compressions are -

Example 1: **Determine** how much energy a spring with a spring constant of 15 N/m stores if it is stretched by 1.6m.

$$E_e = \tfrac{1}{2}\,kx^2$$
$$= \tfrac{1}{2}\,(15\text{N/m})\,(1.6\text{ m})^2$$
$$E_e = 19\text{ J}$$