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…

\[ F = kx \]

\[ F = \text{force (N)} \]
\[ k = \text{spring constant for that object (N/m)} \]
\[ x = \text{amount of expansion or compression (m)} \]

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 \( W = kx d = kx^2 \), 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…

![Graph showing Force vs Distance of Expansion](image)

We are just letting go of it here...

Spring is now back to its original

Distance of Expansion (m)

Force (N)

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

\[ E_e = \frac{1}{2} k x^2 \]

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

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

\[ E_e = \frac{1}{2} k x^2 \]

\[ = \frac{1}{2} (15 \text{N/m}) (1.6 \text{m})^2 \]

\[ E_e = 19 \text{ J} \]