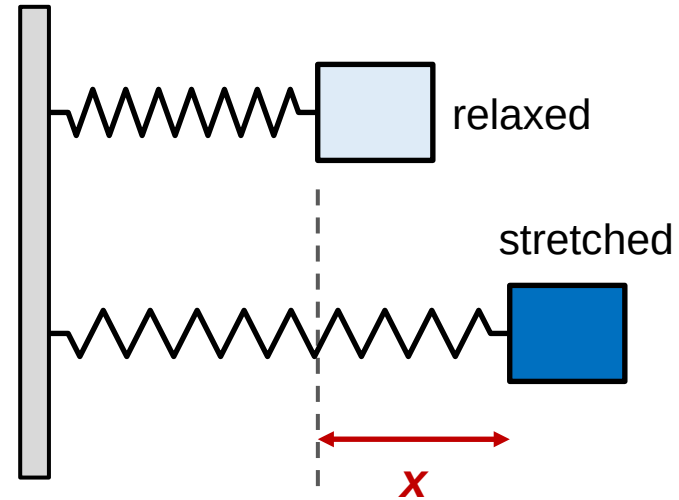


Essential Question

How does a stretched spring store energy?

Elastic Potential Energy

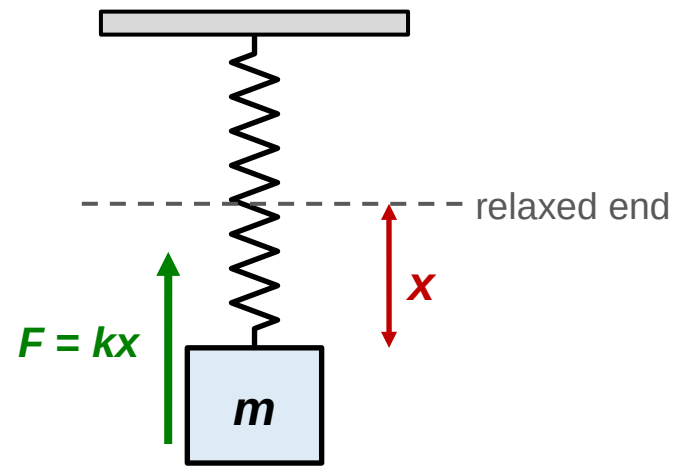
- Stored by stretching or squeezing
- Springs, rubber bands, trampolines
- More stretch: more energy



$x = \text{stretch from the relaxed length}$

Hooke's Law

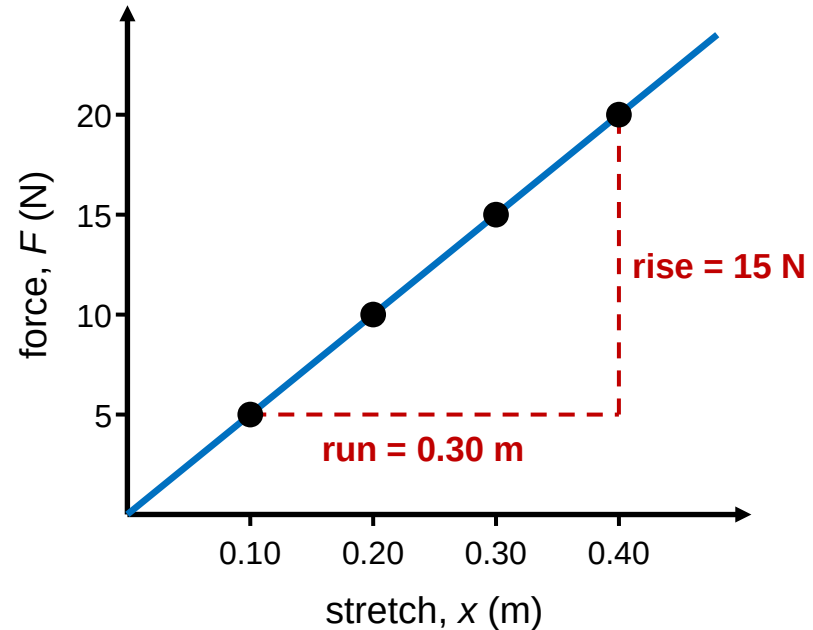
- Spring force: $F = kx$
- x : stretch from relaxed length (m)
- k : spring constant (N/m)



bigger k = stiffer spring

Finding k from a Graph

- Hang masses, measure stretch
- Graph force vs. stretch
- Slope = k



$$\text{slope} = 15 \text{ N} \div 0.30 \text{ m} = 50 \text{ N/m}$$

The Elastic Energy Equation

$$PE_e = \frac{1}{2}kx^2$$

PE_e

elastic energy (J)

k

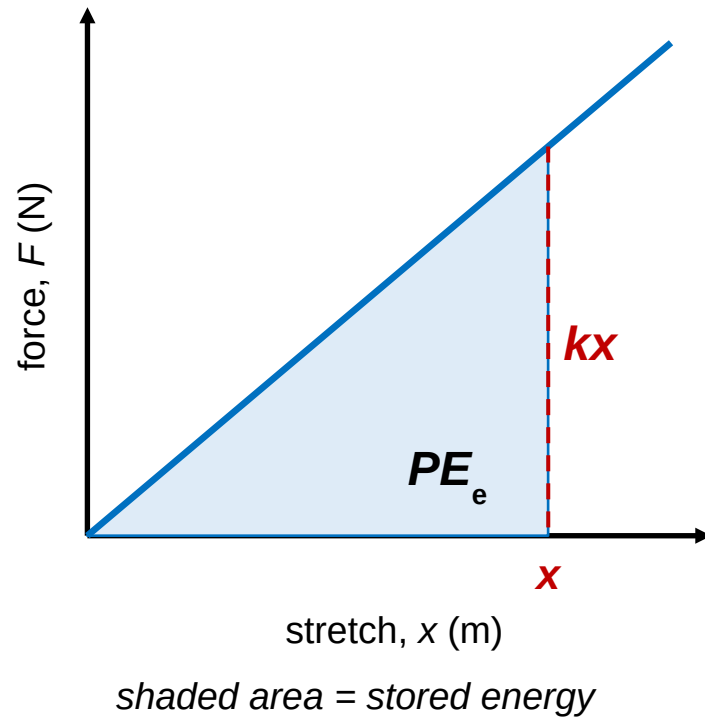
spring constant (N/m)

x

stretch (m)

Where the $\frac{1}{2}$ Comes From

- Work to stretch = area under graph
- Triangle area = $\frac{1}{2} \times \text{base} \times \text{height}$
- $\frac{1}{2} \times x \times kx = \frac{1}{2}kx^2$



Solving for Any Variable

- Write the equation first
- Find k : $k = 2PE_e / x^2$
- Find x : square root last

$$PE_e = \frac{1}{2}kx^2$$

↓ $\times 2, \div k$

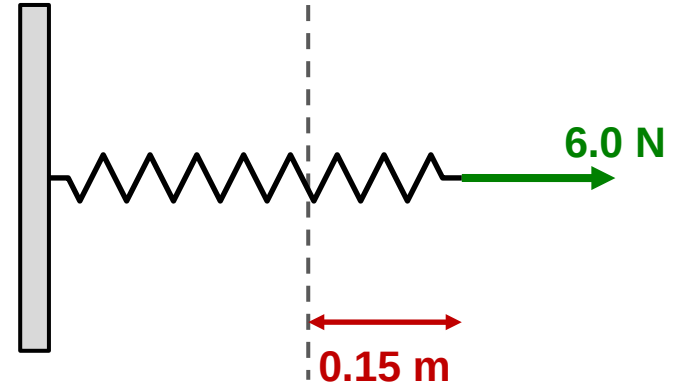
$$x^2 = 2PE_e / k$$

↓ square root

$$x = \sqrt{(2PE_e / k)}$$

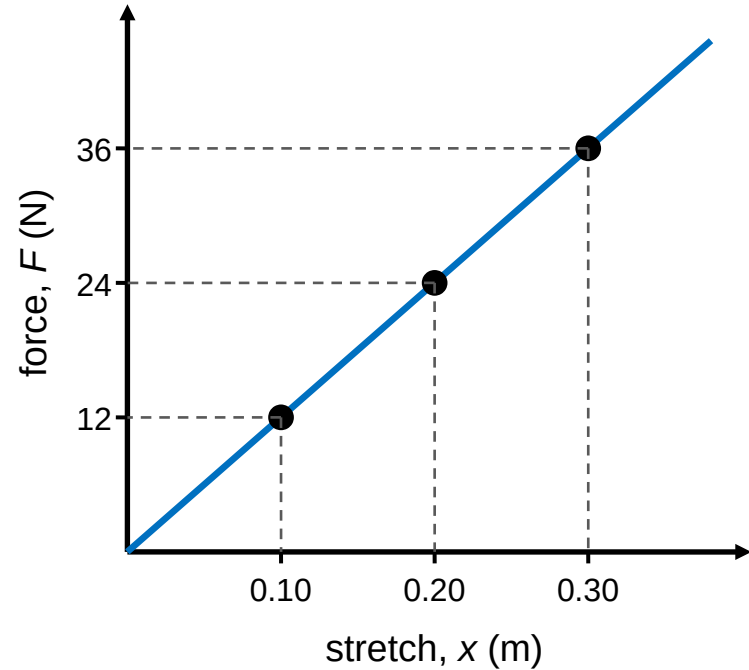
Example: Spring Constant

A 6.0 N force stretches a spring 0.15 m from its relaxed length. What is the spring constant?



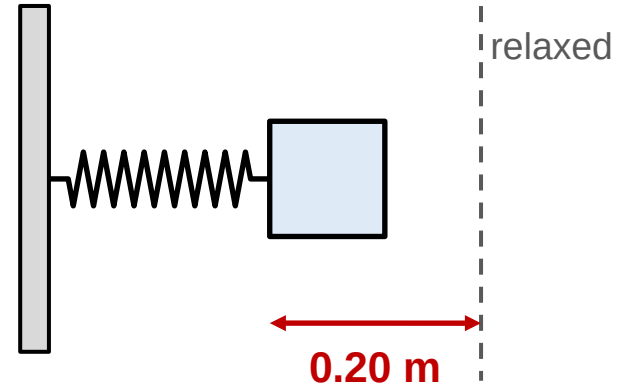
Example: Reading the Graph

A student hangs masses on a spring and graphs force vs. stretch. Use the graph to find the spring constant.



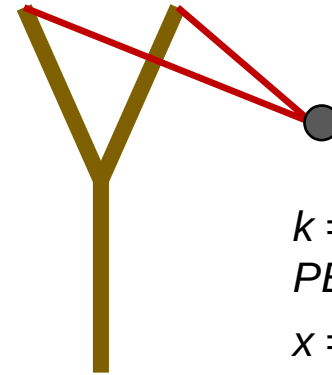
Example: Compressed Spring

A toy launcher has a spring with $k = 250 \text{ N/m}$. It is squeezed 0.20 m from its relaxed length. How much elastic potential energy does it store?



Example: Slingshot Stretch

A slingshot band acts like a spring with $k = 400. \text{ N/m}$. How far must it be stretched to store 18 J of energy?



$$\begin{aligned}k &= 400. \text{ N/m} \\ PE_e &= 18 \text{ J} \\ x &= ?\end{aligned}$$

Big Ideas

- Hooke's law: $F = kx$
- k = slope of force vs. stretch graph
- $PE_e = \frac{1}{2}kx^2$: energy stored in a spring
- Double the stretch: 4× the energy