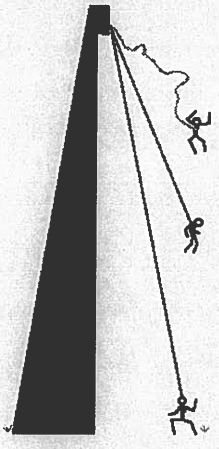
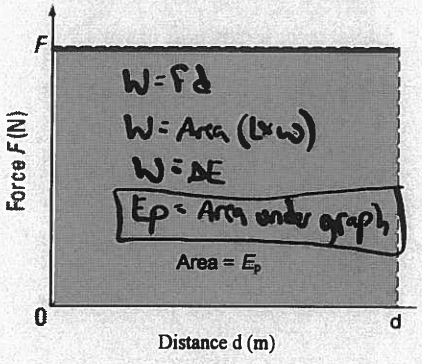
L05 - Elastic Potential Energy

Potential Energy: The amount of energy stored in an object due to its position

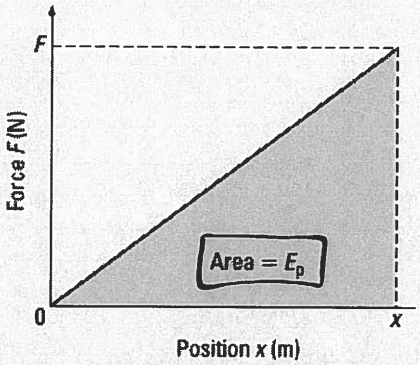


Work is the area under a Force-Distance graph.

Force vs. Position for Constant Force

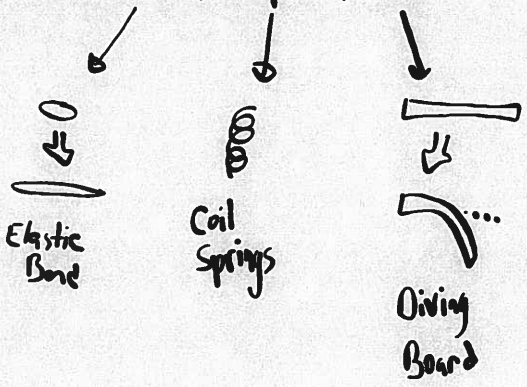


Force vs. Position for an Elastic System



Q1: What do you notice about the force required to stretch/bend an object?

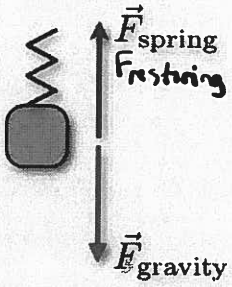
More force → More stretch/compress/bend



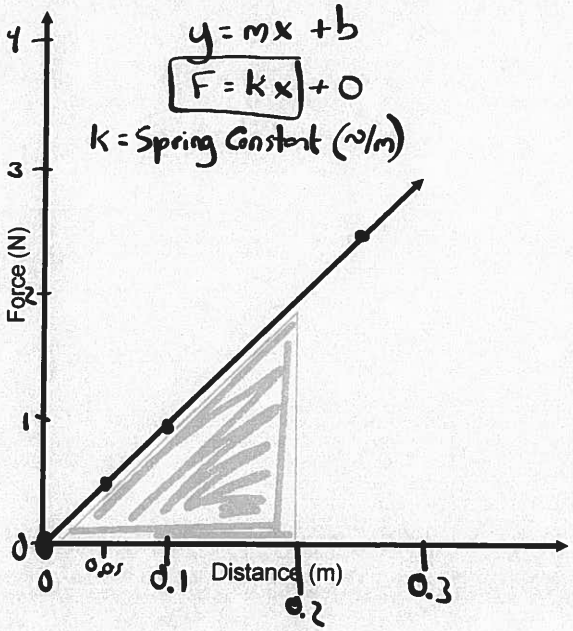
Springs and Elastics - Colorado PhET

$F_g = mg$

Distance (m)	Mass (g)	Force (N)
4.9cm = 0.049m	50g = 0.05kg	0.490S N
9.8cm = 0.098m	100g = 0.1kg	0.981 N
24cm = 0.24m	250g = 0.25kg	2.4525N
0	0	0



Graphing Force vs. Distance - What is the Slope?



k is the spring constant and describes the stiffness of the spring.

Q2: Graph Force versus Stretch.

Symbol	Quantity	Unit
F	Force	Newtons (N)
x	Distance	Meters (m)
k	Spring Constant	(N/m)

Q3: Calculate the Spring constant.

$m = \frac{rise}{run} = \frac{2.4525}{0.24} = 10.21875\ N/m$

$k = 10.2\ N/m$

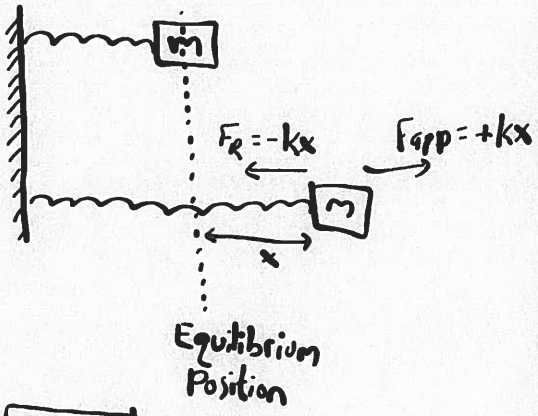
Q4: Calculate the potential energy stored in the spring if it was pulled to 0.20 meters.

$Area = \frac{1}{2}(b)(h) = \frac{1}{2}(0.2)(1.9)$

$E_p = 0.19\ J \qquad = 0.19\ J$

Hooke's Law

$$\vec{F}_s = -k\vec{x}$$

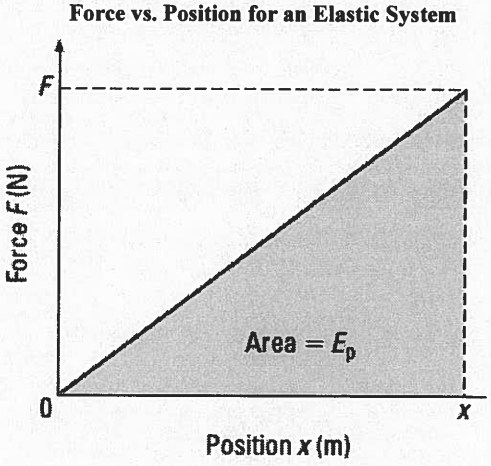


$F = kx$

Scalar version 100% of the time.

k = Spring Constant (N/m)
x = Stretch (m)

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



E_p = Area under graph
$= \frac{1}{2}(b)(h)$
$= \frac{1}{2}(x)(F)$ where $F = kx$
$= \frac{1}{2}(x)(kx)$

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

Use the following information to answer Q5-Q6:

> A spring is stretched to a position 35.0 cm from its equilibrium position. At that point the force exerted on the spring is 10.5 N.

$F = kx$ $\quad E_p = \frac{1}{2}kx^2$

Q5: What is the elastic potential energy stored in the spring?

$x = 0.35m$
$F = 10.5N$
$E_p = ?$

$F = kx$
$10.5 = k(0.35)$
$k = 30 N/m$

$E_p = \frac{1}{2}kx^2$
$= \frac{1}{2}(30)(0.35)^2$
$E_p = 1.8375\ J$

Q6: If the stretch in the spring is allowed to reduce to 20.0 cm, what is the change in the elastic potential energy?

$E_p = \frac{1}{2}kx^2$
$= \frac{1}{2}(30)(0.20)^2$
$E_p = 0.6\ J$

$\Delta E_p = 1.2375\ J$

Use the following information to answer Q7-Q8:

> An archer pulls on a bow that has a spring constant of 350 N/m over a distance of 55cm. The bow is released, and all of the potential energy is converted into the kinetic energy of the arrow. $m_{arrow} = 18g$

Q7: How much force was required to keep the bow stretched at 55cm?

$F = kx$

$= (350)(0.55)$

$= 192.5N$

Q8: How fast was the arrow moving when initially released?

$E_p \rightarrow E_K$

$\frac{1}{2}kx^2 \rightarrow \frac{1}{2}mv^2$

$\frac{1}{2}(350)(0.55)^2 \rightarrow \frac{1}{2}(0.018)v^2$

$52.9375 \rightarrow \frac{1}{2}(0.018)v^2$

$v^2 = 5881.94$

$v = 76.7 m/s$

Practice

Elastic Potential:	Pg 301 #1-5
Work, Potential and Kinetic:	Pg 305 #2,3,5,6,8,9,11