# Elastic Potential Energy

## Hooke's Law

The restoring force in a spring or elastic is directly proportional to the amount the spring is stretched (+) or compressed (−) from its natural length.

$$F = -kx$$

where F is the restoring force (N)
k is the sping or force constant (N/m)
x is the distance stretched (+) or compressed (−) (m)

It is easier to work with the applied force rather than the restoring force:

$$F_a = kx$$

← A more practical form of Hooke's Law

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$F_a = 133\,N$

$x = +71\,cm$

$k = ?$

Hooke's Law:

$$F_a = kx$$

$$k = \frac{F_a}{x}$$

$$k = \frac{133\,N}{0.71\,m}$$

$$k \doteq 1.9 \times 10^2\,N/m$$

Work and Potential Energy

Work must be done to stretch or compress a spring. By doing work on the spring, energy is transferred to the spring in the form of elastic potential energy.

$$\boxed{E_e = \frac{1}{2}kx^2}$$

Where $E_e$ is the elastic potential energy (J)
$k$ is the spring or force constant (N/m)
$x$ is the distance stretched or compressed (m)

Applying the Work-Energy Theorem:

$$W = \Delta E_e$$

or $$W = E_{e_2} - E_{e_1}$$

* Note $W \neq F\Delta d$ since F is not constant.

* If the spring were not stretched to begin with, $E_{e_1} = 0$

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$k = 75\,N/m$

$x = -28\,cm$ ← m

a) $\Delta E_e = ?$

b) $F_a = ?$

a) $\Delta E_e = E_{e_2} - \cancel{E_{e_1}}$ 0 (not stretched)

$\Delta E_e = E_{e_2}$

$\Delta E_e = \frac{1}{2}kx^2$

$\Delta E_e = \frac{1}{2}\left(75\frac{N}{m}\right)(-0.28\,m)^2$

$\boxed{\Delta E_e \doteq 2.9\,J}$

b) $F_a = kx$

$F_a = \left(75\frac{N}{m}\right)(-0.28\,m)$

$F_a \doteq -21\,N$

↑ pushing/compressing.

TODO: PP/258
PP/261