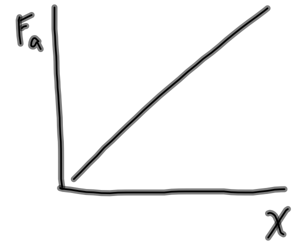
Elastic Potential Energy

Hooke's Law

The restoring force is directly proportional to the amount stretched:
(elastic/spring)

$$F \propto x$$

$$F = -kx$$



Where F is the restoring force (N)
k is the spring constant $\left(\frac{N}{m}\right)$
x is the distance stretched past the unstretched state (m)

Hooke's Law was originally written in terms of the restoring force, but it is usually more convenient to work with the force causing the stretch instead (i.e. the applied force)

$$F_a = kx$$ ← more practical form

mp/257

$F_a = 133\text{ N}$
$x = 71\text{ cm}$
$k = ??$

$$F_a = kx$$

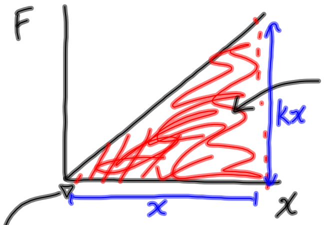
$$k = \frac{F_a}{x}$$

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

$$k \doteq 1.9 \times 10^2\ \text{N/m}$$

Elastic Potential Energy

Consider an elastic being stretched



area = work done to stretch an elastic.

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

where E_e is the elastic potential energy (J)
k is the spring constant ($\frac{N}{m}$)
x is the amount of stretch (m) (+)
compression (-)

$W = \Delta E_e$

$W = E_{e_2} - \cancel{E_{e_1}}^{0}$ unstretched

area = E_{e_2}

$\frac{1}{2}bh = E_{e_2}$

$\frac{1}{2}(x)(kx) = E_{e_2}$

$\frac{1}{2}kx^2 = E_{e_2}$

MP|260

$k = 75\,N/m$

$x = -28\,cm$

a) $\Delta E_e = ?$

b) $F_a = ?$

a)

$\Delta E_e = E_{e_2} - \cancel{E_{e1}}^{0}$

$\Delta E_e = E_{e_2}$

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

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

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

So 2.9 J of work would be done to compress the spring. Recall the work-energy theorem? $W = \Delta E_e$

more generally: $\boxed{W = \Delta E}$

b) The force needed to compress:

$F_a = kx$

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

$\boxed{F_a = -21\,N}$

compressing

\+ stretch
\- compress

TO DO:

① PP|250 + PP|254 (Gravitational P.E.)
② PP|258 + PP|261 (Elastic P.E.)