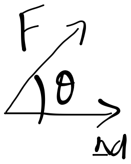
Review of Work + Energy

$W = F_{\parallel}\Delta d$

$W = F\Delta d\cos\theta$



W = area under F-d graph

$W = \Delta E$

Situations for no work.

$E_k = \frac{1}{2}mv^2$

$E_g = mgh$

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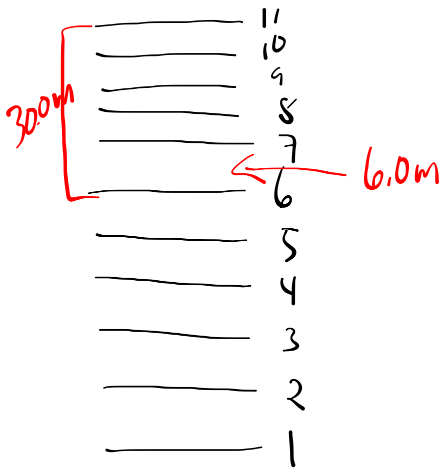
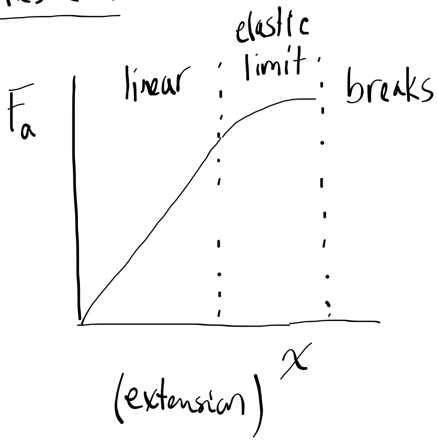


a) $E_g = mg\overset{12.0\,m}{\boxed{h}}$

Hooke's Law



Where the graph (F vs x) is linear, the elastic obeys Hooke's Law

$$F \propto x$$

$$\boxed{F = -kx}$$

It is more practical to express Hooke's Law in terms of the applied force:

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

↑ slope on F_a vs x graph

Where F is the restoring force in the elastic/spring (N)

k is the spring constant / force constant $\left(\frac{N}{m}\right)$

x is the extension (+) / compress (−) (m)

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$F_a = 133 N$

$x = \boxed{+} 71 cm$

↑ extension

$k = ?$

Using Hooke's Law:

$$F_a = kx$$

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

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

$$\boxed{k = 1.9 \times 10^2 N/m}$$

Elastic Potential Energy

The energy stored in a spring or elastic due to it being stretched (+) or compressed (-) from its normal length.

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

where E_e is the elastic potential energy (J)
k is the spring constant (N/m)
x is the extension or compression of the spring/elastic from its normal length (m)

In order to stretch an elastic, you are applying a force in the direction of the displacement so you are doing work. If you do work on the elastic, then you are increasing the elastic potential energy.

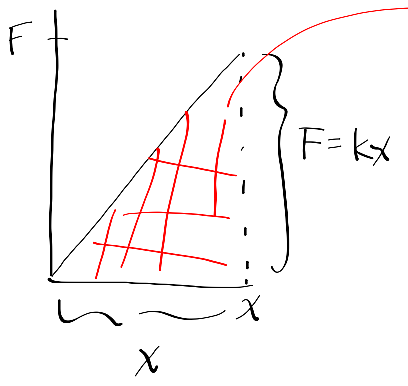
work-energy theorem. →

$$W = \Delta E_e$$

$$W = E_{e_2} - \cancel{E_{e_1}}$$

0 if unstretched/uncompressed to start with

Consider the F - x graph:



Area = $\frac{1}{2}bh$

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

$\Delta E = W = \frac{1}{2}kx^2$

but $E_{e_1} = 0$

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

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$k = 75 N/m$

$x = -28 cm$

compressed

a) $\Delta E_e = ?$

b) $F_a = ?$

a) $\Delta E_e = E_{e_2} - \cancel{E_{e_1}}$ 0 (uncompressed)

$\Delta E_e = E_{e_2}$

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

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

$\boxed{\Delta E_e = 2.9 J}$

In order for the potential energy to increase by 2.9J, then 2.9J of work had to be done.

b) $F_a = kx$

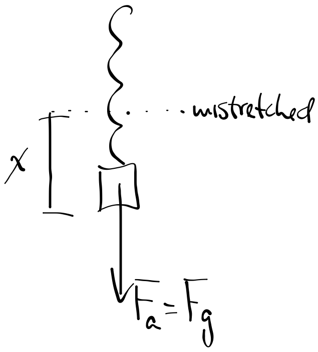
$F_a = (75\frac{N}{m})(-0.28 m)$

$F_a = -21 N$

compressing (pushing spring)

21N is needed to compress the spring by 28 cm

What about a mass hanging on a spring?



$F_a = kx$

$F_g = kx$

$mg = kx$

TODO:

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* NOTE:

You MUST use $W = \Delta E_e$ to find work done on a spring or elastic. DO NOT use $W = F_{\parallel}\Delta d$ because the force is not constant.