MECHANICAL ENERGY

Goal:

- to be familiar with types of energy
- to be able to calculate kinetic and potential energy

In physics, energy is...

the ability to do work.

WORK-ENERGY THEOREM:

$$W = \Delta E_k$$

For us three types of energy make up mechanical energy

KINETIC ENERGY: related to motion

GRAVITATIONAL POTENTIAL ENERGY: stored energy from force of gravity

ELASTIC POTENTIAL ENERGY: stored energy from elastic forces (springs)

From last year,

Kinetic Energy is ...

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

$$\Delta E_k = \frac{1}{2}m\Delta v^2$$

Determine the kinetic energy of a 625-kg roller coaster car that is moving with a speed of 18.3 m/s.

$1\ J = 1\ N \cdot m$

$1\ N = 1\ kg \cdot m/s^2$

$$E_k = \frac{1}{2}(625\ kg)(18.3\ m/s)^2$$

$$= 104\,653\ kg \cdot m^2/s^2 = 104\,653\ J$$

And
Gravitational Potential Energy is...

$$E_g = mgh$$

$$\Delta E_g = mg\Delta h$$

How high is a 20 kg mass if it has 1000 J of graviational potential energy?

$$1000\ J = 20\ kg(9.8\ N/kg)\,h$$

$$5.1\ J/N = h$$

$$h = 5.1\ m$$

Another form of potential energy comes from springs (or other elastic objects).

Elastic potential energy is...

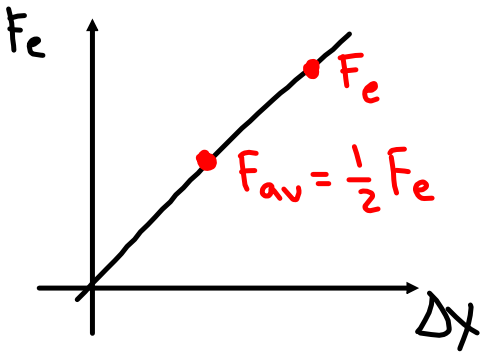
$E_e = \frac{1}{2} F_e \Delta d$

$= \frac{1}{2} k \Delta x \Delta d$

$= \frac{1}{2} k \Delta x^2$

$E_e = \frac{1}{2} k \Delta x^2$

$F_e = k \Delta x$



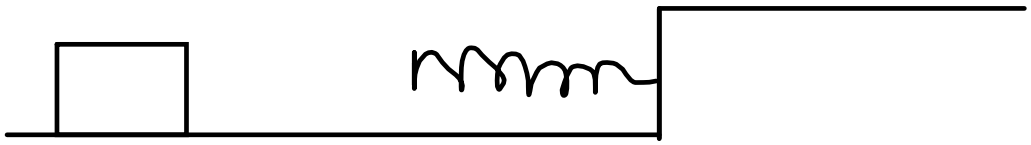
What is the elastic potential energy stored in a spring whose force constant is 160 N/m when it is compressed 8.0 cm?

$$E_e = \frac{1}{2}(160\ N/m)(0.08\ m)^2$$

$$= 0.512\ Nm$$

$$= 0.512\ J$$

A block with a mass of 2.5 kg is sliding across a frictionless surface at 3.0 m/s when it hits a stationary spring bumper, fixed at one end, whose force constant is 360 N/m. By what amount does the block compress the spring, before coming to rest?



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

$= \frac{1}{2}(2.5\,kg)(3.0\,m/s)^2$

$= 11.25\,J$ ← Total Mechanical Energy

$(E_g = 0 + E_e = 0)$

When block comes to rest $E_k = 0$, all the energy is transfered into E_e.

$E_e = 11.25\,J$

$\frac{1}{2}k\Delta x^2 = 11.25\,J$

$\frac{1}{2}(360\,N/m)\Delta x^2 = 11.25\,J$

$\Delta x = 0.25\sqrt{J/N/m}$

$\sqrt{\frac{J}{N/m}} = \sqrt{\frac{N\cdot m}{N/m}}$

$= \sqrt{\frac{m}{1}}$

$= \sqrt{m^2}$

$= m$

$\Delta x = 0.25m$