# CONSERVATION OF ENERGY

The conservation of energy is one of the most important ideas in science. It says that there is something called "energy" and that the total amount of energy in the universe is conserved. However, there are many different kinds of energy, and even though the total amount of energy doesn't change, it does change forms - going from one kind of energy to another.

So what is Energy? As unsatisfying as this is, energy is basically an invention - though stupidly useful. Energy is something that depends on an objects position or speed or even its temperature.

# CONSERVATION OF ENERGY

The Total amount of energy (i.e. K+U etc.) on a system will be constant, unless work is done on it, in which case the total energy changes by the amount of work done.

$$\sum E_i + \sum W = \sum E_f$$

$\sum E_i$:

* anything moving? $\frac{1}{2}mv^2$
* anything up in air? $mgh$
* any springs? $\frac{1}{2}kx^2$

$\sum W$:

Work done by NON-Conservative force

* friction $(-fd)$
* applied Forces $\int F \cdot dx$

$\sum E_f$:

Same 3 Questions!!

$K$?

$U_g$?

$U_s$?

Note: You only care about the energy types at the very start of the problem (i.e. the initial conditions) and at the very end of the problem (i.e. the final conditions)

This means you should NOT break the problem up into "part 1" then "part 2" etc.

conservation of energy is easier than Newton's Laws!

The 3 equations we have so far ($K$, $U_g$ & $U_s$) are all types of <u>MECHANICAL ENERGY</u> - the energy types that are used in mechanics. When doing a physics problem in this class, those are basically all you have to worry about.

There are MANY other types of energy though! Here are a few (you do not have to worry about using these)

$E_0 = mc^2$

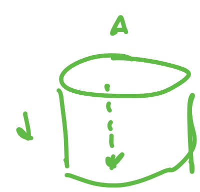
$Q = mc\Delta T$

$E = h\nu$

enthalpy

$U_e = \frac{kq_1q_2}{r}$

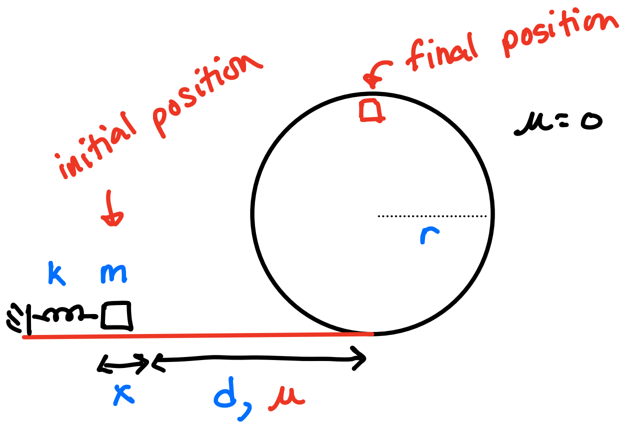
* $U_g = -G\frac{m_1m_2}{r}$




$P = \frac{F}{A}$

$V = Ad$

$\therefore PV = \left(\frac{F}{A}\right)(Ad) = Fd$

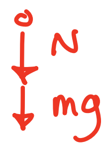



What is minimum x so that mass just makes the loop-the-loop?

$$\Sigma E_i + \Sigma W = \Sigma E_f$$

$$\frac{1}{2}kx^2 - \mu mg(d+x) = mg(2r) + \frac{1}{2}mv^2$$

From Circles @ top of loop




$$\Sigma F = \frac{mv^2}{r}$$

For min speed, N=0

$$\left( \cancel{N} + mg = \frac{mv^2}{r} \right) \quad N=0$$

$$mg = \frac{mv^2}{r} \leftarrow \text{min speed @ top to just make the loop}$$

$$v^2 = rg$$

So we end up with

$$\frac{1}{2}kx^2 - \mu mg(d+x) = mg(2r) + \frac{1}{2}mrg$$

$$\frac{1}{2}kx^2 - \mu mgx - \mu mgd = mg\left(\frac{5}{2}r\right)$$

$$\frac{1}{2}kx^2 - \mu mgx - mg\left(\mu d + \frac{5}{2}r\right) = 0$$

Then do a big blobby Quadratic Formula to solve...

Another Note: The term "Mechanical Energy" refers to the equations we have in this class.

$K$, $U_g$ & $U_s$ are all mechanical energy