Recall that the total work done by gravity when an object goes up and then back down to its orignal height is ZERO.

Case 1: $\bigcirc$ m, $\downarrow h$

$W_g = +mgh$

Case 2: $\uparrow h$, $\bigcirc$ m

$W_g = -mgh$

So $\uparrow\downarrow h$

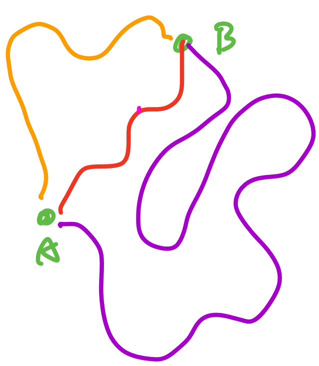
$\Sigma W_g = -mgh + mgh$

$\Sigma W_g = 0$!

The same thing would be true for a spring that stretches then unstretches. In both cases, the total work done by the force when the object ends at its starting point is zero. The fancy math way of saying that is

$\oint \vec{F} \cdot d\vec{r} = 0$ $\longrightarrow$ total work on a "closed loop" $= 0$

A second thing to notice about gravity & springs is that

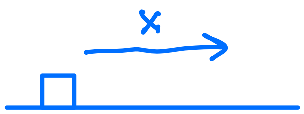


The total work done by gravity when an object moves from point A to point B does NOT depend on HOW it gets there - it ONLY depends on the change in height. So the total work on all 3 paths below is the same! (Also, if A=B, then the total work is zero.)

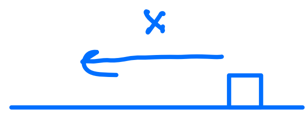
There is a fancy math way of saying this as well:

$\int_a^b \vec{F} \cdot d\vec{r}$ is the same for all paths from a to b

BUT Friction is different!!

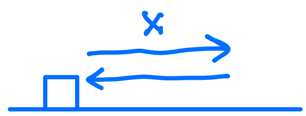


$W_f = -fx$



$W_f = -fx$

So



$$\Sigma W_g = -fx - fx = -2fx$$

$\vec{f}$

$$\oint \vec{F} \cdot d\vec{r} \neq 0$$

W by friction depends on the path - f can <u>never</u> do + work

We classify forces based on this idea:

* CONSERVATIVE → $\oint \vec{F} \cdot d\vec{r} = 0$

* NON-CONSERVATIVE → $\oint \vec{F} \cdot d\vec{r} \neq 0$

Gravity, springs & elastics are Conservative forces.
Friction is a non-conservative force.

Notice that a conservative force <u>has</u> to be able to do both + and − work. In a sense, it is reversable. Non conservative forces can't. Friction can <u>ONLY</u> do negative work.

when a non-conservative force does negative work to stop something, the object loses its kinetic energy and that's it. Nothing else happens. When a conservative force does negative work the kinetic energy is only "lost" temporarilly - b/c the conservative force can then do the exact same amount of positive work on the object - giving back its kinetic energy! It's as if the kinetic energy was stored for awhile.

* Conservative Forces have Potential Energy! *

In ch. 7, we would say gravity does negative work when something goes up. In ch. 8, we say it gains Potential Energy.

The official definition of potential energy (U)

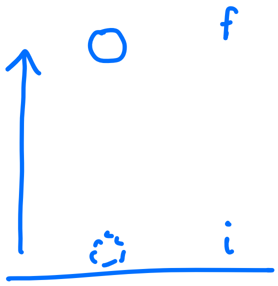
$$\Delta U = -\int F dx$$

In English: the change in Potential Energy of an object because of a conservative force is the negative of the work done by that force.

For us, this means two equations, that should look familiar:

$$U_g = mgh \qquad U_s = \frac{1}{2}kx^2$$

Potential Energy is the energy something has due to its position (h or x). Kinetic energy is the energy something has due to its motion (v)



$W_g = -mgh$

$W_g = mgh$

when we let it go...

$W_g = +mgh$

Potential Energy $= mgh$

$\cancel{W_g = mgh}$

$U_g = mgh$

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

$K = \frac{1}{2}mv^2$ motion

- stored energy → due to position
- the work that can potentially be released by the force