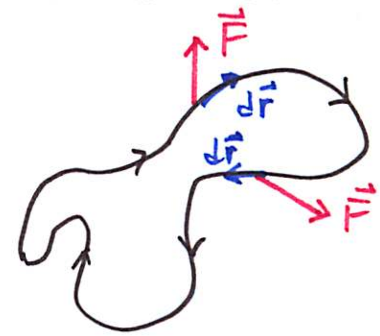
POTENTIAL ENERGY, ENERGY CONSERVATION:

A force is conservative if it satisfies

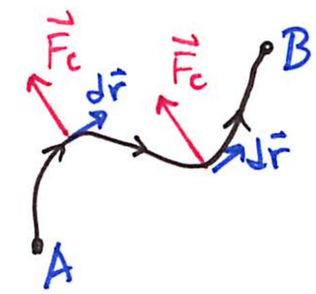
$$\oint \mathbf{F} \cdot d\mathbf{r} = 0$$



for any closed path! If a force is conservative, you can define a potential energy that corresponds to it.

Potential Energy:

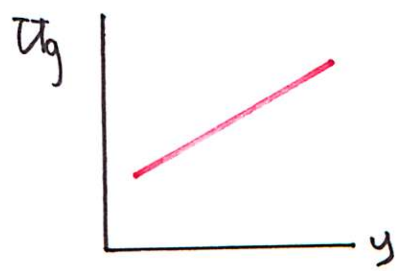
$$\Delta U_{AB} = -\int_A^B \mathbf{F}_c \cdot d\mathbf{r}.$$



The easiest way to understand this definition is to realize that it says the change in potential energy is equal to the work we would have to do against the conservative force $\mathbf{F}_c$ to carry the system from A to B.

Gravitational Potential Energy:

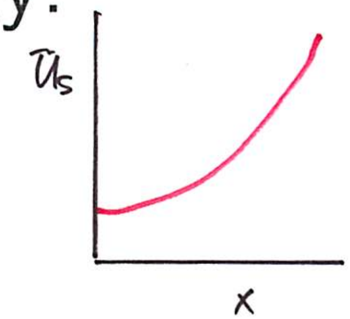
$$U_g(y) = mgy$$



near the earth's surface.

Spring Potential Energy:

$$U_s(x) = \frac{1}{2}kx^2.$$



Conservation of Energy:

$$\text{Define } E = \sum_i K_i + \sum_j U_{cj}.$$

If a KE for every part of the system and a PE for every conservative force acting that does work is included, then E will not change, no matter what happens within the system.

Nonconservative Forces:

$$\Delta E = W_{\text{nc}}.$$

Force from Potential Energy:

$$\mathbf{F} = -\nabla U.$$

Internal Energy:

Imagine a book is at rest on a big table. You give it a shove, and it slides across the table with initial kinetic energy which quickly (because of kinetic friction) goes to zero. The kinetic friction is an external non-conservative force doing work on the book, so this is no surprise. But James Joule pointed out that if you look at the interacting systems involved, energy is conserved. The book is a system of atoms which have kinetic and potential energy relative to one another, described by some internal energy $\mathcal{E}$. Similarly the table is a system of interacting atoms with internal energy $\mathcal{E}'$. As the book slides across the table, atoms in the book collide with atoms in the table... the result is that the initial kinetic energy is transferred to the system of atoms of book and table. No energy is lost. As the book's kinetic energy goes to zero, the sum of $\mathcal{E} + \mathcal{E}'$ increases by that amount.

What is lost? What is lost is *the work done to give the book its initial kinetic energy.* That is gone forever once the initial KE is distributed as internal energy. Random atomic collisions will never cause the book at rest to suddenly have a kinetic energy relative to the table again!