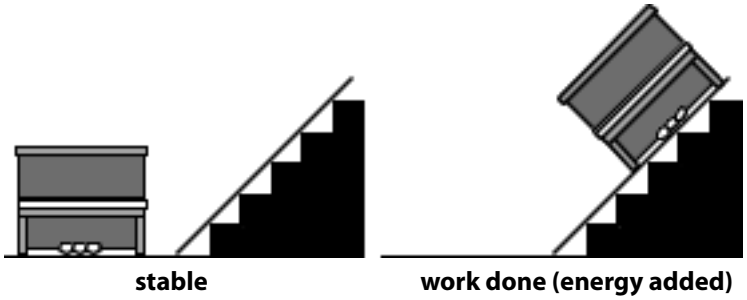
PhyzGuide: Potential Energy

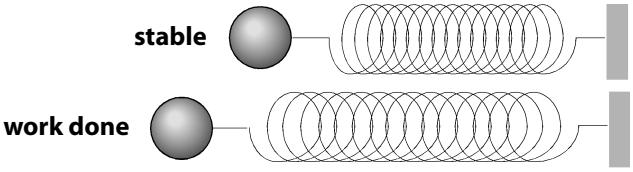
"Energy of Position"

KOYAANISQATSI

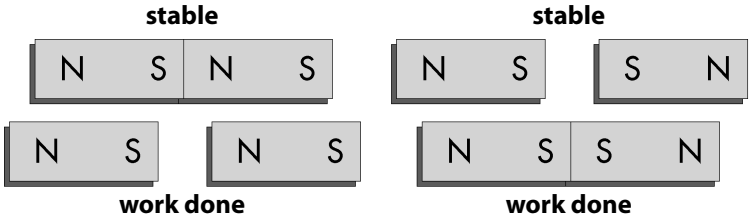
If an object is in stable equilibrium, work is required to move it away from its equilibrium position. A piano is stable on ground level, so work is required to move it up a flight of stairs.



The mass at the end of a spring has a distinct equilibrium position, so work is also required to move it away from that position.

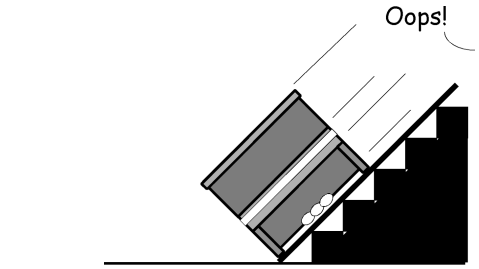


Since opposite poles of magnets attract and like poles repel, work is also required to pull the opposite poles of magnets apart, or to push like poles together.

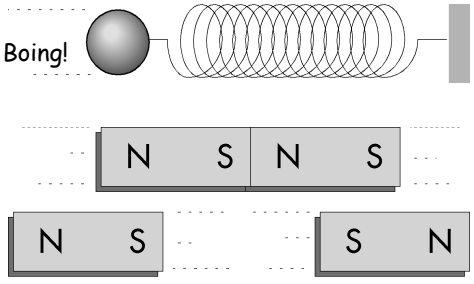


POTENTIAL ENERGY

Work energy is *put into* an object to move it *away* from equilibrium. Conversely, energy is *released* when the object *returns* to equilibrium.



The piano releases energy as it falls down the stairs. The mass attached to the spring releases energy as it returns to its equilibrium position. Energy is also released as opposite magnetic poles come closer and closer together, or if like poles get farther and farther apart.



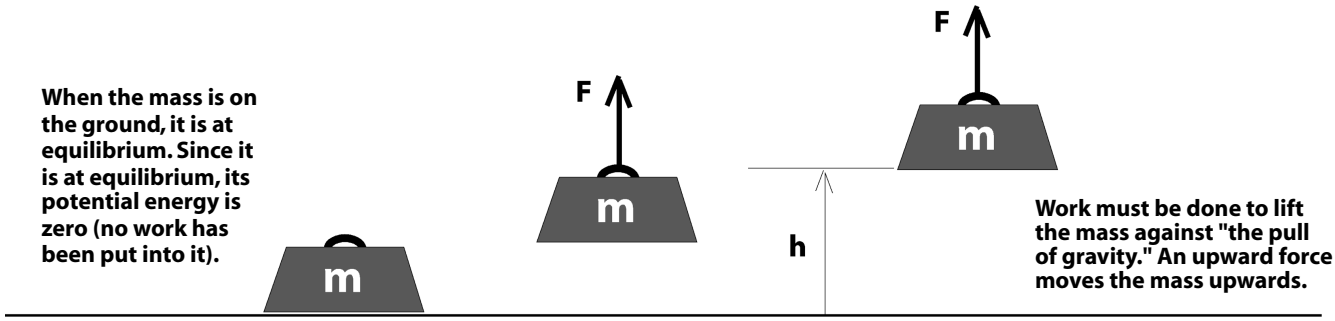
The energy that is released as each object returns to its equilibrium position turns out to be *equal* to the amount of work that was put in to move it away from equilibrium. We refer to the energy stored in an object due to its position or location as potential energy (PE). The work you do to separate attracting magnets becomes potential energy; if the magnets are allowed to rejoin, they release that potential energy.

There are many forms of potential energy: gravitational, elastic (spring), electric, magnetic, nuclear. Notice that each form relates to some kind of force.

Koyaanisqatsi is a word from the Hopi language meaning life out of balance. It is also the title of an unusual and beautiful 1983 film.

GRAVITATIONAL POTENTIAL ENERGY

An object possesses **gravitational potential energy** if it is above a possible equilibrium position. How much gravitational potential energy does a given object have? It depends on how much work would have to be done to lift it above an equilibrium position:



How much work is done?

$W = Fd$

$F = mg$ (the weight of the object)

$d = h$ (the height of elevation)

$W = mgh$

How much potential energy does the object now have? Exactly as much work as was done to elevate it!

$PE = mgh$

WHY THEY CALL IT "POTENTIAL ENERGY"

The formal definition of potential energy goes something like this: the **potential energy** of an object is its *potential* to perform work due to its position or location.

Suppose you wanted to drive a stake into the ground. Doing so requires work because a *force* would have to act on the stake to drive it through a *distance* down into the ground. You could simply try pushing the stake. Or you might try dropping a heavy object onto it. The dropped object can perform work as shown below.