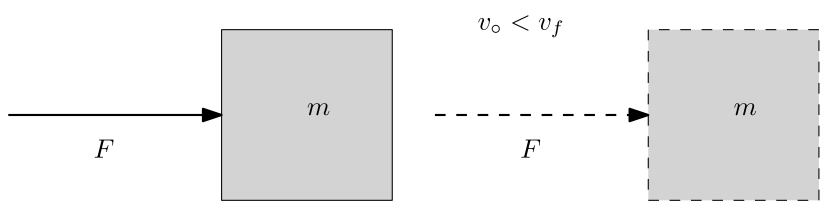
There are some important relationships between force, energy, and momentum. Recall that if an unbalanced force is acting on a body, the body will accelerate.

If a force acts on a body for a finite time interval, what would be the difference between a long time interval and a short time interval for the same force?



Newton defined force as the rate of change of momentum.

$$F = \frac{\Delta \rho}{\Delta t}$$

Multiplying by time gives us an interesting way to understand the effect of a force F acting for a time interval Δt.

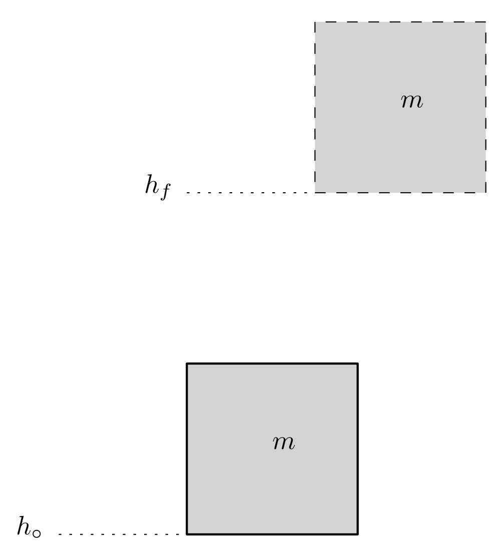
$$F\Delta t = \Delta \rho$$

Thus the effect of a force acting for a specific amount of time is a change in momentum. This quantity is called *impulse* and is given the variable I. It has the same units as momentum.

$$I = F\Delta t$$

Consider a body of mass m in a gravitational field. If the body starts at a height of $h_\circ$ and ends up at a height of h_f,

- What has changed?
- Where did that energy come from?
- What had to happen for the body to move from one place to another?



The mass on the previous page had to have been acted upon by a force, and we can see that the result was a change in (potential) energy. A force can also effect a change in kinetic energy, or other kinds of energy. When this happens, we say that there was *work* done on the mass. Work has units of energy.

$$W = F \cdot d \cos\theta$$

In the above equation, θ is the angle between the force and the path d. If the force is in the same direction as the motion of the mass, the equation becomes

$$W = F \cdot d$$

Now consider the example of climbing stairs. If you walk up the stairs, you are changing your potential energy by *doing work*. What is the difference between running up the stairs and walking slow? The rate of change of energy (or the rate at which work is done) is called *power*. Power is represented by the variable P and has units of J/s.

$$P = \frac{\Delta E}{\Delta t} \qquad\qquad P = \frac{W}{\Delta t}$$