# Notes about "Work"

1. To have work, we are typically acting against some force. That force could simply be the force due to gravity, or it could come from somewhere else.

   - Newton's Second Law of Motion: Force is mass times acceleration, or $F = ma$. If we move in a straight line with position $s(t)$, then acceleration is the second derivative:
   $$F = m \cdot s''(t)$$
   - In SI metric system,
     - units of mass: $kg$,
     - displacement: meters,
     - time: seconds
     - force in newtons, $N = kg \cdot m/s^2$.
       A force of 1 N acting on a mass of 1 kg produces acceleration of 1 m/s$^2$
   - For problems on the Earth, we assume that the force due to gravity is approximately constant, $g = 9.8$ m/s$^2$ (this is acceleration).
   - In US Customary units, force is in pounds (mass is not separately computed) and $g$ is 32 ft/sec$^2$

2. Work when the force is constant: Work = Force times Distance.

   - Units of work in SI: $W$ is newton-meters aka (J)oule. Note that
   $$W = \big[(\text{ mass (in kg)}) \cdot (\text{ accel (in meters per sec}^2))\big] \cdot (\text{ dist in meters})$$
   - U.S. Customary: $F$ in lbs, $d$ in feet - $W$ is in foot-pounds.

3. How much work? In the first case, take force to be constant:

   - Lift a 1.2kg book 0.7 meters: $W = Fd = (mg)d = (1.2)(9.8)(0.7) = 8.2J$
   - Lift a 20 lb book 6 feet? $W = 20 \cdot 6 = 120$ foot-pounds.

4. Hooke's Law: The restorative force on a spring that is stretched past equilibrium is proportional to the length stretched. That is, if the spring is stretched $x$ units past equilibrium, the force to restore it is $kx$ (in the opposite direction).

5. Free fall: In problems about free fall, we assume that the only force is the (downward) force of gravity (we ignore things like air resistance), so that the object's acceleration is constant.

I will provide the weight of water (62.5 pounds per cubic feet) or the density of water (1000 kg per cubic meter) if it is needed in a problem. I will also give you the value(s) of $g$ (either 9.8 or 32) in the problem statement. You should know Hooke's Law (for example, find the spring constant if it takes a certain amount of force to stretch a spring a certain amount). I won't ask you specifically about units, but keeping units in mind can help you keep the numbers straight.

*Quick Note: Numbers used on quiz or exam questions may seem outlandish- This is so the arithmetic is not overly burdensome. The homework problems should be more realistic.*