7.6: In Summary

1. The change in the momentum of a system produced by a force $\vec{F}$ acting over a time Δt is given the name of "impulse" and denoted by $\vec{J}$. For a constant force, we have $\vec{J} = \Delta\vec{p} = \vec{F}\Delta t$.
2. Work, or "doing work" is the name given in physics to the process by which an applied force brings about a change in the energy of an object, or of a system that contains the object on which the force is acting.
3. The work done by a constant force $\vec{F}$ acting on an object or system is given by $W = \vec{F} \cdot \Delta\vec{r}$, where the dot represents the "dot" or "scalar" product of the two vectors, and $\Delta\vec{r}$ is the displacement undergone *by the point of application of the force while the force is acting*. If the force is perpendicular to the displacement, it does no work.
4. For a system that is otherwise closed, the net sum of the amounts of work done by all the external forces is equal to the change in the system's total energy, when all the types of energy are included. Note that, for deformable systems, the displacement of the point of application may be different for different forces.
5. The result in 4 above holds only provided the boundary of the system is not drawn at a physical surface on which dissipation occurs. Put otherwise, kinetic friction or other similar dissipative forces (drag, air resistance) must be included as internal, *not* external forces.
6. The work done by the internal forces in a closed system results only in the conversion of one type of energy into another, always keeping the total energy constant.
7. For a system with no internal energy, like a particle, the work done by all the external forces equals the change in kinetic energy. This result is sometimes called the *Work-Energy theorem* in a narrow sense.
8. For any system, if $\vec{F}_{ext,net}$ (assumed constant) is the sum of all the external forces, the following result holds:

   $$\vec{F}_{\text{ext,net}} \cdot \Delta\vec{r}_{cm} = \Delta K_{cm}$$

   where K_{cm} is the translational (or "center of mass") kinetic energy, and $\Delta\vec{r}_{cm}$ is the displacement of the center of mass. This is only sometimes equal to the net work done on the system by the external forces.
9. For an object o sliding on a surface s, the energy dissipated by kinetic friction can be directly calculated as

   $$\Delta E_{\text{diss}} = |F^k_{s,o}||\Delta x_{so}|$$

   where $|\Delta x_{so}| = |\Delta x_o - \Delta x_s|$ is the distance that the two surfaces in contact slip past each other. This expression, with a negative sign, can be used to take the place of the "work done by friction" in applications of the results 7 and 8 above to systems involving kinetic friction forces.
10. The *power* of a system is the rate at which it does work, that is to say, takes in or gives up energy: $P_{av} = \Delta E/\Delta t$. When this is done by means of an applied force F, the instantaneous power can be written as $P = Fv$, or, in three dimensions, $\vec{F} \cdot \vec{v}$.