5.5: In Summary

1. For *conservative interactions* one can define a potential energy U, such that that in the course of the interaction the total mechanical energy $E = U + K$ of the system remains constant, even as K and U separately change. The function U is a measure of the energy stored in the *configuration* of the system, that is, the relative position of all its parts.
2. The potential energy function for a system of two particles must be a function of their *relative* position only: $U(x_1 - x_2)$. However, if one of the objects is very massive, so it does not move during the interaction, its position may be taken to be the origin of coordinates, and U written as a function of the lighter object's coordinate alone.
3. For a system formed by the earth and an object of mass m at a height y above the ground, the gravitational potential energy can be written as $U^G = mgy$ (approximately, as long as y is much smaller than the radius of the earth).
4. The elastic potential energy stored in an ideal spring of spring constant k and relaxed length x_0, when stretched or compressed to an actual length x, is $U^{spr} = \frac{1}{2}k(x - x_0)^2$.
5. For an object in one dimension, with position coordinate x, which is part of a system with potential energy $U(x)$, the motion can be predicted from the "energy landscape" formed by the graph of the function $U(x)$. The idea, elaborated in Section 5.1.2, is to imagine the equivalent motion of an object sliding without friction over the same landscape, under the influence of gravity.
6. The fundamental interactions currently known in physics are gravity, the strong nuclear interaction and the electroweak interaction (which includes all electromagnetic phenomena). These are all conservative.
7. At a macroscopic level, one finds a number of interactions and associated energies that are derived from electromagnetism and quantum mechanics. Two important examples are chemical energy, and elastic energy (which is energy associated with the elasticity or "springiness" of a body). Elastic energy can often be described approximately by a potential energy function, and as such be included in calculations of the total mechanical energy of a system.
8. Interactions between macroscopic objects almost always involve the conversion of some type of energy into another. Typically, some of the total mechanical energy is always lost in the conversion process, because it is impossible to keep at least some of the energy from spreading itself randomly among the microscopic parts that make up the interacting objects. This is an intrinsically irreversible process known as *dissipation of energy.*
9. Most of the time the *dissipated energy* ends up as *thermal energy*, which is energy associated with a random agitation at the atomic or molecular level.
10. A *closed system* is one that does not exchange energy with its surroundings. This is not necessarily the same thing as an isolated system (which is one that does not exchange momentum with its surroundings). For a closed system, the sum of its macroscopic mechanical energy (kinetic + potential) and all its other "internal" energies (chemical, thermal), must be a constant.