

Conservative Forces

* 藍色 highlight 的是句子的動詞，紅線是句子的動詞。

Conservative forces **have** these two equivalent properties:

1. The work done by a conservative force on a particle moving between any two points **is** independent of the path taken by the particle.
2. The work done by a conservative force on a particle moving through any closed path **is** zero. (A closed path **is** one for which the beginning point and the endpoint are identical.)

The gravitational force **is** one example of a conservative force; the force **that** an ideal spring exerts on any object attached to the spring **is** another. The work done by the gravitational force on an object moving between any two points near the Earth's surface **is** $W_g = -mg\hat{j} \cdot [(y_f - y_i)\hat{j}] = mgy_i - mgy_f$. From this equation, **notice** **that** W_g depends only on the initial and final y coordinates of the object and hence **is** independent of the path. Furthermore, W_g **is** zero when the object moves over any closed path (where $y_i = y_f$).

For the case of the object-spring system, the work W_s done by the spring force **is** **given** by $W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$ (Eq. 7.12). We **see** **that** the spring force **is** conservative **because** W_s depends only on the initial and final x coordinates of the object **and** **is** zero for any closed path.

We can **associate** a potential energy for a system with a force acting between members of the system, but we can **do** so only if the force is conservative. In general, the work W_{int} done by a conservative force on an object that **is** a member of a system as the system changes from one configuration to another **is** equal to the initial value of the potential energy of the system minus the final value:

$$W_{\text{int}} = U_i - U_f = -\Delta U \quad (7.23)$$

The subscript "int" in Equation 7.23 **reminds** us that the work we are discussing is done by one member of the system on another member and is therefore *internal* to the system. It **is** different from the work W_{ext} done *on* the system as a whole by an external agent. As an example, **compare** Equation 7.23 with the specific equation for the work done by the spring force (Eq. 7.12) as the extension of the spring changes.