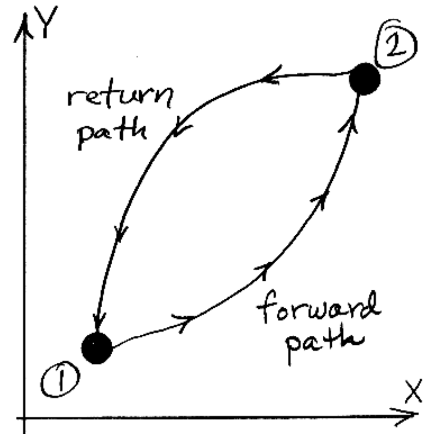
ME 2580 Dynamics
Conservation of Energy for Particles

Conservative and Nonconservative Forces



Consider a particle that moves from position 1 to position 2 along one path (forward path) and back again to position 1 along a second path (return path) as shown in the diagram. A force acting on the particle is said to be ***conservative*** if the net work it does over the closed path is ***zero***. Suppose, for example, that the work done by the force as the particle moves from position 1 to position 2 is ***positive***, then the force does the same amount of work as the particle returns to position 1, except that this work is ***negative***.

In this way, conservative forces do not permanently add or remove energy from a system. When the conservative force is doing negative work, the system is said to be gaining ***potential energy*** that can later be transformed into ***kinetic energy***. It is also true of conservative forces that the work done in moving from one position to another is ***independent*** of the path of the particle. Examples include weight forces and spring forces.

Forces whose ***net*** work around a closed circuit is ***not*** zero are called nonconservative forces. The work done by these forces as a particle moves from one position to another is ***dependent*** on the path of the particle. Examples include friction and damping forces.

Potential Energy (*V*)

The work done by conservative forces can be written in terms of a potential energy function, V. For weight forces and linear spring forces, we have

$V = mgy$ (y is the height of the particle ***above*** some arbitrary datum)

$V = \frac{1}{2}ke^2$ (e is the elongation or compression of the spring)

The work done by the force as the particle moves from position 1 to position 2 is given by $U_{1\to2} = -(V_2 - V_1) = V_1 - V_2$. For systems with multiple conservative forces, the total potential energy is $V_{total} = \sum V$.

Principle of Conservation of Energy

For a system of particles acted on only by conservative forces, the principle of work and energy can be restated as

$$\sum K_1 + \sum U_{1\to2} = \sum K_1 + \sum V_1 - \sum V_2 = \sum K_2$$

or

$$\boxed{\sum K_1 + \sum V_1 = \sum K_2 + \sum V_2}$$ (***total mechanical energy*** is same in all positions)