

11-4 POTENTIAL ENERGY AND EQUILIBRIUM

The potential energy of a body is a measure of its capacity for doing work. The potential energy can be defined quantitatively as the amount of work that the body is capable of doing against outside forces as it passes from a given position or configuration to some standard or reference position or configuration. A compressed spring is capable of doing work by virtue of the relative positions (configuration) of its particles. Potential energy is expressed in the same units as work: in joules (J) if SI units are used and in $\text{ft} \cdot \text{lb}$ or $\text{in.} \cdot \text{lb}$ if U.S. Customary units are used.

Conservative Force Systems When the work done by a body depends only on the initial and final configurations of the system and not at all on the paths taken by the parts of the system while moving from the initial state to the final state, the system is a conservative force system. Conservative force systems occur frequently in engineering. A common example is that of a system consisting of the earth and an elevated body (rigid or deformable). The work done on the body during any displacement is equal to the earth pull (weight) of the body times the vertical displacement of the center of gravity of the body. Any intermediate positions occupied by the body as it moves from its initial position to its final position have no effect on net work done on the body.

Another example is that of an elastic body such as a spring. If the body is elastic, the energy possessed by the body in a given strained condition (that is, for a given configuration of its particles) is independent of the movements of the particles that occurred while the body was being put in the given strained condition. The standard configuration may be arbitrarily chosen, but, for convenience, it is usually chosen so that the potential energy of the body is initially positive or zero. Thus, in the case of the earth and an elevated body, the earth is considered fixed and the standard configuration occurs when the body is in contact with the earth.

Nonconservative Force Systems The most common case of a nonconservative system is one in which the system does work against frictional forces. Any rigid body under the action of a force system in which friction does not occur (or may be considered negligible) is a conservative system provided no change in state or condition of the body except that of position or configuration takes place.