## 1. 6.4 Work

(1) The work done when a *constant* force $F$ is applied to move and object a distance of $d$ is

$$W = Fd$$

(2) Suppose an object is moved from $x = a$ to $x = b$ and the force applied at position $x$ is given by $F(x)$. Then the work done to move the object from $x = a$ to $x = b$ is

$$\lim_{n\to\infty} \sum_{k=1}^{n} F(x_k^*)\Delta x_k =$$

## 2. Examples

**Example 2.1. Hooke's Law** *states that the force required to maintain a spring stretched $x$ units beyond its natural length is proportional to $x$. In other words, $F(x) = kx$ where $k$ is a constant depending on the particular spring.*

*(1) Suppose a spring has natural length of 0.5 m and that a 25-N force is required to keep it stretched to a length of 0.8 m. How much work is required to stretch it from 0.5 to 1 m?*

*(2) Suppose 5 J of work is needed to stretch a spring from 0.2 m to 0.3 m and another 3 J is needed to stretch it from 0.3 m to 0.5 m. Find the natural length of the spring.*

**Example 2.2.** *A 20 ft cable weighs 80 lbs and hangs from the ceiling of a building without touching the floor. Determine the work that must be done to lift the bottom end of the chain all the way up until it touches the ceiling.*

**Example 2.3.** *Suppose a cylindrical tank has height 10m, the radius of the base is 8m, and it is half filled with water. Find the amount of work necessary to move all of the water out of the top of the tank.*

*Use the density of water is 1000* $kg/m^3$ *and the following physics formulas.*

*mass = density× volume*

*Force needed to overcome gravity = mass ×acceleration due to gravity.*

**Example 2.4.** *Suppose a conical tank has height 10m, the radius of the top is 8m, and it is half filled with water (the water is filled to a height of 5m). Find the amount of work necessary to move all of the water out of the top of the tank.*

*Use the density of water is 1000* $kg/m^3$ *and the following physics formulas.*

*mass = density× volume*

*Force needed to overcome gravity = mass ×acceleration due to gravity.*