11-4.2 Gravitational Potential Energy

The work done by the weight of a body is obtained by multiplying the weight W of the body by the vertical displacement dh of the center of gravity of the body. Thus,

$$U = W\,dh \tag{11-24}$$

If the displacement is toward the center of the earth, the work is positive; if it is away from the center of the earth, the work is negative. The work is independent of the path followed by the body in getting from its initial position to its final position; it depends only on the vertical displacement h of the center of gravity of the body. Thus,

$$U = V_g = \int_0^h W\,dh = Wh = mgh \tag{11-25}$$

The gravitational potential energy possessed by the body is available to do work as the body returns to a lower position. The work done by the weight W as it displaces downward will be positive. This downward movement will produce a decrease in the gravitational potential energy of the body equal to the work done. Thus,

$$\Delta U = W\,\Delta h = -\Delta V_g \tag{11-26}$$

During a virtual displacement δh of the body, the virtual work δU done by the weight of the body, and the change in virtual gravitational potential energy δV_g of the body are given by the expression

$$\delta U = -\delta V_g = W\,\delta h \tag{11-27}$$