26.4: Conservation of Energy

One of the most important laws in physics is called the law of conservation of energy. It states that, if you add up all the energy in a system in all its forms (giving the total energy E), that total energy will not change with time. Energy may be converted from one form to another, but the total energy will remain constant as long as the system is closed (i.e. no energy enters or leaves the system).

The conservation of energy is not only an important physical principle, but it can also be used as a shortcut in solving certain problems.

Example 26.4.1

A body of mass m is dropped from a height h. What is its impact velocity (i.e. its velocity just before hitting the floor)?

Solution

There are a number of ways of approaching this problem. We could, for example, use Eq. (8.7.11) for $x(t)$ to solve for the time t it takes the body to fall, then substitute into Eq. (8.7.5) to find the impact velocity. Alternatively, we could use Eq. (8.7.7) to find the impact velocity directly.

A third approach is to use the conservation of energy. When the body is a height h above the floor, its potential energy is $U_i = mgh$, and, since it's at rest, its kinetic energy is $K_i = 0$; its total energy is therefore $E_i = U_i + K_i = mgh$. Just before it hits the ground, all of that potential energy has been converted to kinetic energy; its potential energy is now $U_f = 0$, its kinetic energy is $K_f = mv^2/2$, and its total energy is therefore $E_f = U_f + K_f = mv^2/2$. Since total energy E is conserved, we must have

$$E_i = E_f \tag{26.4.1}$$

$$mgh = \frac{1}{2}mv^2 \tag{26.4.2}$$

or, solving for v,

$$v = \sqrt{2gh}. \tag{26.4.3}$$