

READING PASSAGE 2: LAWS OF THERMODYNAMICS

Energy is the ability to perform work, and it is around us all the time in many forms. Work is a force that can cause an object to move. Work done by animals and machines requires a quantity of energy. For an animal or machine to do something that requires energy, the energy must be changed from one form to another during the process of work.

The First Law of Thermodynamics, loosely interpreted, states that energy can neither be created nor destroyed; it changes from one form to another. During a transformation, some of the available energy is used to cause work to happen, and in the process the energy changes to a different form.

At first glance, this seems like a wonderful arrangement. If energy can't be destroyed, can we continue to use it over and over again?

The answer is "no" because of the Second Law of Thermodynamics which states that heat always flows spontaneously from hotter to colder regions of matter. When this spontaneous process happens, energy loses its ability to do work even if it is not destroyed..



A child on a swing provides an example of this principle. Mechanical energy in the child's body is used to set the swing in motion. When no more energy is put into the swing by pushing or pumping, it will gradually stop. It would seem that all of the energy was gone. If you had a very sensitive thermometer, however, you could measure that some of the mechanical energy had changed (transformed) to a low heat. It would show an increase in the temperature of the swing and the swing supports and in the air around the swing.

The heat is not sufficient to be useful, however. It is passed off to cooler surroundings. In such cases the energy is said to be degraded (weakened) to a point where we are not able to use it.

The child on the swing can demonstrate what entropy means. The swing slowed down and came to a stop. The energy was not all gone, but it was so scattered that it could do no more work. The principle of entropy is this: eventually all energy, as it is used, becomes so random that it loses its ability to do work. Each time an energy transformation takes place, some of the original energy is "lost" to waste heat.

Another example of the principle of entropy was shown during the incandescent light bulb demonstration. The purpose of a light bulb is to produce light (radiant energy); however, all of the electrical energy entering the bulb was not transformed into radiant energy. Most of the electrical energy was transformed to heat (thermal energy).

This is experienced this when when people put their hands near a light bulb. The thermal energy generated during this energy transformation cannot be used as it dissipates (is randomly scattered) into the air. It is "lost" because it was not captured and consequently, was not able to perform any useful work. This "lost" thermal energy is also called waste heat. Waste heat is produced every time an energy transformation takes place.

Your body is capable of transforming energy from one form to another. For example, if you eat a hamburger and then exercise (lift weights or participate in an aerobics class), all the movement (mechanical energy) that it takes to exercise requires your body to transform the chemical energy in the hamburger into the mechanical energy to make your muscles move. However, all of the chemical energy in the hamburger is not transformed to mechanical energy. Some of the chemical energy is transformed to thermal energy (waste heat).

