Energy

Introduction

Energy, in physics, the ability or capacity to do work or to produce change. Forms of energy include heat, light, sound, electricity, and chemical energy. Energy and work are measured in the same units—foot-pounds, joules, ergs, or some other, depending on the system of measurement being used. When a force acts on a body, the work performed (and the energy expended) is the product of the force and the distance over which it is exerted.

Potential and Kinetic Energy

Potential energy is the capacity for doing work that a body possesses because of its position or condition. For example, a stone resting on the edge of a cliff has potential energy due to its position in the earth's gravitational field. If it falls, the force of gravity (which is equal to the stone's weight; see gravitation) will act on it until it strikes the ground; the stone's potential energy is equal to its weight times the distance it can fall. A charge in an electric field also has potential energy because of its position; a stretched spring has potential energy because of its condition. Chemical energy is a special kind of potential energy; it is the form of energy involved in chemical reactions. The chemical energy of a substance is due to the condition of the atoms of which it is made; it resides in the chemical bonds that join the atoms in compound substances (see chemical bond).

Kinetic energy is energy a body possesses because it is in motion. The kinetic energy of a body with mass m moving at a velocity v is one half the product of the mass of the body and the square of its velocity, i.e., $KE = 1/2mv^2$. Even when a body appears to be at rest, its atoms and molecules are in constant motion and thus have kinetic energy. The average kinetic energy of the atoms or molecules is measured by the temperature of the body.

The difference between kinetic energy and potential energy, and the conversion of one to the other, is demonstrated by the falling of a rock from a cliff, when its energy of position is changed to energy of motion. Another example is provided in the movements of a simple pendulum (see harmonic motion). As the suspended body moves upward in its swing, its kinetic energy is continuously being changed into potential energy; the higher it goes the greater becomes the energy that it owes to its position. At the top of the swing the change from kinetic to potential energy is complete, and in the course of the downward motion that follows the potential energy is in turn converted to kinetic energy.

Conversion and Conservation of Energy

It is common for energy to be converted from one form to another; however, the law of conservation of energy, a fundamental law of physics, states that although energy can be changed in form it can be neither created nor destroyed (see conservation laws). The theory of relativity shows, however, that mass and energy are equivalent and thus that one can be converted into the other. As a result, the law of conservation of energy includes both mass and energy.

Many transformations of energy are of practical importance. Combustion of fuels results in the conversion of chemical energy into heat and light. In the electric storage battery chemical energy is converted to electrical energy and conversely. In the photosynthesis of starch, green plants convert light energy from the sun into chemical energy. Hydroelectric facilities convert the kinetic energy of falling water into electrical energy, which can be conveniently carried by wires to its place of use (see power, electric). The force of a nuclear explosion results from the partial conversion of matter to energy (see nuclear energy).

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