The Meaning of Work

In scientific terms, you do **work** when you exert a force on an object that causes the object to move some distance. Work is done on an object when the object moves in the same direction in which the force is exerted. If you push a child on a swing, for example, you are doing work on the child. If you pull your books out of your backpack, you do work on the books. If you lift a bag of groceries out of a shopping cart, you do work on the bag of groceries.

The SI unit of work is the **joule** (JOOL). When force is measured in newtons and distance in meters, the SI unit of work is the newton × meter (N·m), also called a joule (JOOL) in honor of James Prescott Joule, a physicist who studied work in the mid-1800s.
One joule(J) is the amount of work you do when you exert a force of 1 newton to move an object a distance of 1 meter. The picture to the right shows the difference in joules between lifting 2 plants: you would have to exert 25 joules of work to lift the lighter plant and 50 joules of work to lift the heavier plant.

To lift the heavier plant, you would have to exert a force of 100 newtons. So the amount of work you do would be 100 newtons × 0.5 meter, or 50 N·m. As you can see, you do more work to lift the heavier object.

Energy, Work, and Power

When wind moves a house, or even a leaf, it causes a change. In this case, the change is in the position of the object. Recall that work is done when a force moves an object through a distance. The ability to do work or cause change is called **energy**. So the wind has energy.

Work and Energy

When an object or living thing does work on another object, some of its energy is transferred to that object. You can think of work, then, as the transfer of energy. When energy is transferred, the object upon which the work is done gains energy. Energy is measured in joules—the same units as work.

Power and Energy

You may recall that **power** is the rate at which work is done. If the transfer of energy is work, then power is the rate at which energy is transferred, or the amount of energy transferred in a unit of time.

$$\text{Power} = \frac{\text{Energy transferred}}{\text{Time}}$$

Power is involved whenever energy is being transferred. For example, a calm breeze has power when it transfers energy to lift a leaf a certain distance. A tornado transfers the same amount of energy when it lifts the leaf the same distance. However, the tornado has more power than the breeze because it transfers energy to the leaf in less time.

Kinetic Energy

Two basic kinds of energy are kinetic energy and potential energy. Whether energy is kinetic or potential depends on whether an object is moving or not.

A moving object, such as the wind, can do work when it strikes another object and moves it some distance. Because the moving object does work, it has energy. The energy an object has due to its motion is called **kinetic energy**. The word *kinetic* comes from the Greek word *kinetos*, which means “moving.”

Potential Energy

An object does not have to be moving to have energy. Some objects have stored energy as a result of their positions or shapes. When you lift a book up to your desk from the floor or compress a spring to wind a toy, you transfer energy to it. The energy you transfer is stored, or held in readiness. It might be used later when the book falls to the floor or the spring unwinds. Stored energy that results from the position or shape of an object is called **potential energy**. This type of energy has the potential to do work.

Mechanical Energy

Think about a pass thrown by the quarterback. A football thrown by a quarterback has mechanical energy. So does a moving car or a trophy on a shelf. The form of energy associated with the position and motion of an object is called **mechanical energy**.

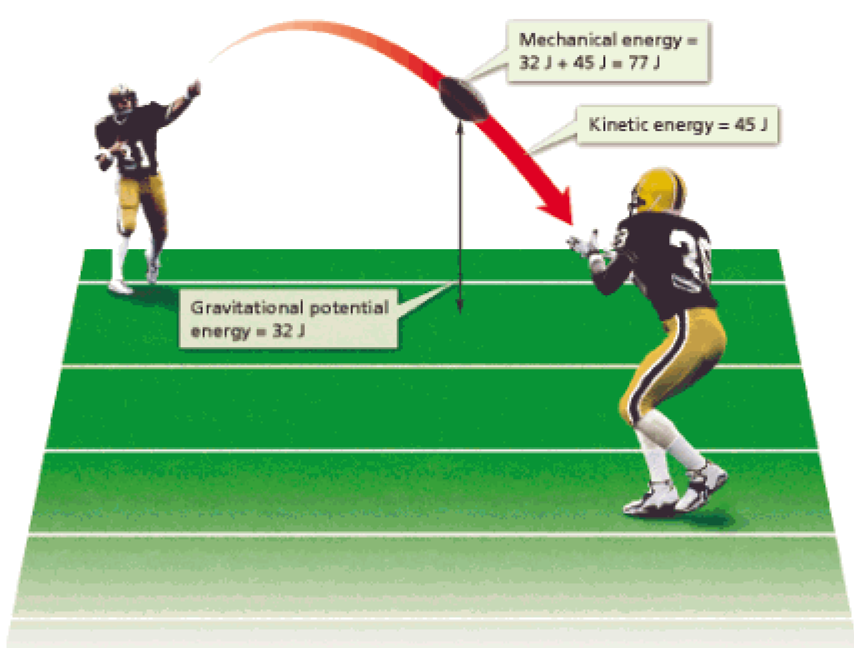
An object’s mechanical energy is a combination of its potential energy and kinetic energy. For example, a thrown football’s mechanical energy is a combination of its position above the ground and its motion. Sometimes an object’s mechanical energy is its kinetic energy or potential energy only. A car moving along a flat road possesses kinetic energy only. A trophy resting on a shelf has gravitational potential energy only. But both have mechanical energy.

An object with mechanical energy can do work on another object. In fact, you can think of mechanical energy as the ability to do work. The more mechanical energy an object has, the more work it can do.

You can find an object’s mechanical energy by adding the object’s kinetic energy and potential energy.

Mechanical Energy = Potential energy + Kinetic energy

You can use this formula to find the mechanical energy of the football in the picture below. The football has 32 joules of potential energy due to its position above the ground. It also has 45 joules of kinetic energy due to its motion. The total mechanical energy of the football is 32 joules + 45 joules, or 77 joules.



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