THE MEANING OF WORK

It isn't hard to understand what most people mean when they talk about work—

"I'm going to work."

"This job is hard work."

"I worked hard to study for this test."

In everyday speech, the word "work" refers to the effort it takes to get things done. Manual labor is seen as work; so is mental labor.

But in science, "work" has a narrow definition. Work is done on an object, a scientist would say, when a force acts on an object and it moves some distance. To calculate the work done on an object, the force that pushes or pulls on the object is multiplied by the distance the object moves. Work involves both force and distance.

Activities that may seem like work to you might *not* seem like work to a scientist. For example, if you sit quietly and study for a long time, a scientist would say that you're not doing any work at all! And you could push against a car until you were exhausted, but if the car didn't move, the scientist would say you had done no work on the car. As you can see, there is a big difference between the everyday use and the scientific use of the word "work."

Two things must happen for a force to do work on an object. First, the force must push or pull on the object. Second, the object must move some distance. Both must happen; otherwise, no work is done. For example, suppose you pick up a heavy book bag and put it on your back. Now a scientist would say that you have done work on the book bag. But exactly how much did you do?

Work is done when a force acts on an object that moves some distance while the force acts.

It's not hard to figure out. Multiply the force needed to lift the bag by the distance the object was lifted. That's it. In other words, for the scientist:

Force (F) × Distance (d) = Work (W)

In mathematical terms, this could be expressed as

Fd = W

The amount of work done equals the product of the force (in newtons) times the distance (in meters) through which the force acts—

Force (N) × Distance (m) = Work (N-m)

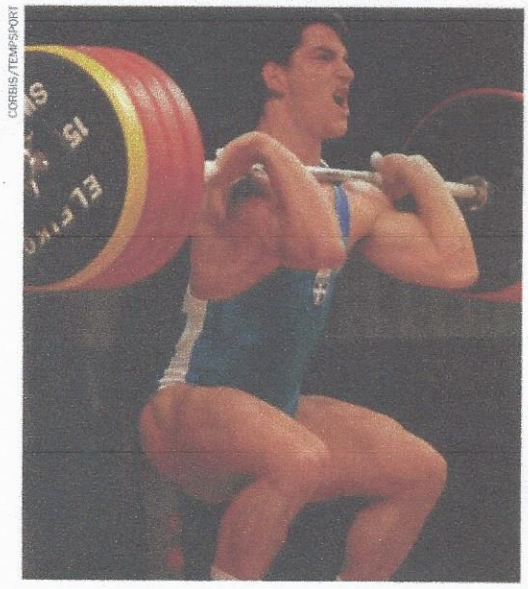
When force and distance are measured using newtons and meters, work is measured in units called newton-meters (N-m). A newton-meter is also called a joule (J), for James Joule, who made important discoveries about work and energy. Work and energy are both measured in newton-meters or joules. In this module you will use newton-meters as the unit of measure for work. Using this unit will remind you how to calculate a value for work. Here's an example:

Michael lifts his book bag, which weighs 25 N, from the floor to a desktop that is 0.80 m above the floor. How much work does Michael do on the bag?

Force × Distance = 25 N × 0.80 m =
20.0 N-m = Work

Michael does 20.0 N-m of work on the book bag.

Why can the weight lifter in the photo on the right be said to be doing no work on the barbell? Because the barbell isn't moving; the weight lifter pushes upward, but the barbell stays in one place above his head. The product of force multiplied by the distance moved equals zero. Remember, according to the scientific definition, work is the product of two things—force and distance moved.



CORBIS/TEMPSPORT

A weight lifter does a lot of work to lift a barbell above his head. The work he does is the product of the weight he lifts and the distance he lifts it.

CORBIS/MIKE KING

This weight lifter is holding the barbell steady over his head. Is he doing any work on the barbell now? Why or why not?