Work

What is work?

We often use the word "work" in our everyday lives. For example, we would say that getting good grades in school takes a lot of hard "work". In physics, the term "work" has a specific meaning.

Work, in physics, occurs when a force acts on an object to move it some distance from the start point (also called displacement). Work is calculated as the force times the distance. The following equation is used to describe work:

Work = Force * distance

or

W = Fd

How to Measure Work

The standard unit for work is the joule (J). The joule is the same as a newton-meter where the newton is the force and the meter is the distance.

Force and Displacement

The distance (or displacement) in work is the distance from the start point to the end point. The amount of traveling in between doesn't matter. For example, if you lift a weight off the ground and then place it back on the ground the distance (or displacement) is zero.

Don't be Tricked

Measuring work can sometimes be tricky. In order for the equation W = Fd to work, the force used in the equation must be the force used to cause the displacement or distance. Also, remember for work to have occurred, the object must be displaced by the force. Otherwise, the distance, or "d", in the formula is 0 and the work will be 0.

Here are some examples:

- If someone is pushing on a wall with all their might, but the wall doesn't move, no work has occurred. This is because the distance is zero.
- If someone is using force to hold a rock over their head while walking eastward across a field, no work has occurred. This is because the force is not in the same direction (the force is up) as the distance moved by the rock (eastward).
- If you do a full push-up, lifting yourself up and then back down, the total work is zero. This is because the total distance from the starting point to the ending point is zero.
- If you drop your pencil, then work has occurred. This is because the displacement of the pencil from your hand to the ground is greater than zero and is in the same direction as the force acting on the pencil, which is gravity.

Example problem:

A baseball player throws a ball with a force of 10 N. The ball travels 20 meters. What is the

total work?

W = F * distance
W = 10 N* 20 meters
W = 200 joules

More Complicated Problems

When the angle between the force and displacement is not 0 degrees or 90 degrees, a more complex formula for work is used. This formula includes the angle theta (Θ) which is the angle between the force and displacement.

$$W = F * d * \cos \Theta$$

In the case where the force and the displacement are in the exact same direction theta = 0 and the cos Θ = 1. In the case where the force has no impact on the displacement and theta = 90 degrees, then cos Θ = 0 and, therefore, the work = 0.

Interesting Facts about Work

- Work is a scalar quantity, not a vector quantity. This means that, unlike force and velocity, it has no direction, only a magnitude.
- Another unit of work is the foot-pound. One foot-pound is equal to 1.35581795 joules.
- The joule is also used as the standard unit of measure for energy.
- Negative work is when force acting on an object hinders the object's displacement.