Intro to Work and Energy

# Now we turn, no, not turn, we, uh, fling ourselves upon! Yes, that’s the ticket. We fling ourselves upon the grand branch of physics that deals with the wondrous concept of energy! Oh, and also work. Work has a bad reputation with the teeming masses as it has a lot of associations with labor, sweat, toil, etc. – things that actually have nothing to do with the grand science of physics (right? This is because there is no labor, sweat, toil, &tc, in physics! It is never toil to do something that you positively love doing.).

# In physics work one of the grandest things there is! As you shall see.

# Work in the real world is what you do to get a paycheck, &c. It is very likely that if you are employed you are probably not fond of your work. Most people aren’t. Of course there is the odd person, called a ‘workaholic’ who ***lives*** to do work much as you, the dedicated AP Physics student, live to do physics.

# In physics, work has its own special meaning, specifically:***Work is done when a force causes an object to move.***

To be specific, work is the product of the component of a force in the direction of the displacement it causes and the magnitude of the displacement. For work to be accomplished a force has to move an object and the force and displacement have to be in the same direction. If you lift a book a distance of one meter, you have done work on it. The book moved up and the force was directed up. If you hold a heavy book stationary at some height above the floor, you have done no work on it. The force was up, but there was no displacement, so there was no work.

A simple equation for work is:  ***W*** is work, ***F*** is the applied force, and ***Δd*** is the change in displacement.

This is a “special case” equation. The force and the displacement have to be in the same direction. If you took physics last year, this was the equation that you used.

* You lift a 1.2 kg book a distance of 1.0 m, how much work did you do on the book?

This is a simple problem. The force doing the work has the same magnitude as the weight of the book (that’s what it takes to lift it), ***mg***.



The unit we ended up with is a Newton-meter. This is defined in physics as a joule. The symbol for the joule is *J*. (The joule is named after James Joule, a big name in the area of energy.)



Here the ‘***F****’* and ‘***cos θ*** ‘ part of the equation is the component of the applied force that is in the direction of the displacement.



The drawing above represents the motion of a crate being moved by an applied force. The crate is moved a distance . The work done is simply



We find this equation in its AP form as: 

Here is work, is the net force, is the distance the object is moved, and  is the angle the net force makes with the direction of motion.

It’s two equations in one. The first one is for when the angle is zero and the net force has the same direction as the motion. So we can say that 

The second one is used when there is an angle between the net force and the motion direction.

* A force is applied to a crate at an angle of 25°. The crate is dragged across the deck a distance of 2.5 m. If the amount of work done after it has been moved is 1 210 J, what was the applied force?

This is a simple problem, all we have to do is solve it for ***F***!



Work is a scalar quantity. This means you can add and subtract work without treating it as a vector. How convenient!

Joules are a small unit, so it is very common to deal with kJ and MJ. A joule is roughly the amount of work you do when you lift a Big Mac one meter. That’s not very much work, is it?

This brings us to the next exciting topic: energy!

***Energy:*** Energy is another one of those common terms that you hear all the time. Interestingly enough, in everyday language, it is used pretty much correctly. Hmmph. Imagine that.

In physics we define energy as: ***Energy ≡ the ability to do work.***

But what does that mean? Well work is done when something is displaced by a force. If work is done, it takes energy. If you lift a 1 N rock 1 m, you’ve done 1 J of work and expended 1 J of energy.

Energy and work, intimately related as they are, use the same unit.

Energy comes in a vast array of types and all sorts of ways have been devised to classify the different types of energy. No doubt you can think of lots of them. There’s electrical energy, solar energy, nuclear energy, thermal energy, chemical energy, etc. Lots of energy types.

Initially we will be dealing with mechanical energy. This is the energy associated with motion and forces. There are two types of mechanical energy (these types can be applied - and often are – to all types of energy, keep in mind). The two types are ***kinetic energy*** and ***potential energy***