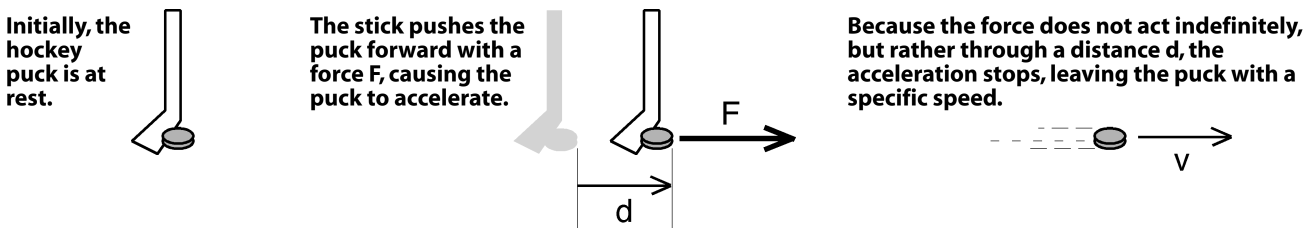
PhyzGuide: Kinetic Energy

"Energy of Motion"

One of the possible results of performing work on an object is to accelerate the object to a different speed. Work can set a stationary object into motion and work can bring a moving object to a stop. Work can increase the speed of a moving object and work can slow a moving object down.

Consider the simplest case. Work is done on a stationary object to set it in motion—perhaps a stationary hockey puck is propelled by a hockey stick.



When the work performed on an object results in accelerating that object to a certain speed, we say that the work energy has been transformed to kinetic energy. **Kinetic energy** (*KE*) is an object's ability to do work by virtue of its motion. You see, once an object has kinetic energy, it can do work (e.g., drive a stake into the ground). And once again, the amount of kinetic energy a moving object has is equal to the amount of work that was done to bring it to that speed.

To have kinetic energy, an object must be an object (i.e., have mass) and it must be moving (i.e., have speed). So, how much kinetic energy does an object of mass *m* and speed *v* have?

$$KE = \frac{1}{2} mv^2$$

"Huh?" You say? Where did that come from? Allow me to show you.

- An object's kinetic energy is equal to the work put into it. $KE = W$
- The work put into it is the product of the force applied and the distance through which the force was applied. $W = Fd$
- The force applied relates to the acceleration and mass by Newton's second law. $F = ma$
- The distance through which the object is accelerated is related to the final speed by the kinematics relationship shown to the right. To simplify our derivation, we chose to consider an object that is initially at rest, therefore $v_0 = 0$. The relation may then be solved for d and the resulting expression can by substituted for d above. $v^2 = v_0^2 + 2ad$, $v_0 = 0$, $d = v^2 / 2a$
- Solving gives the "expected" results. $KE = (ma)(v^2 / 2a) = \frac{1}{2} mv^2$