Momentum and energy

I. Momentum
   A. = Mass x velocity
   B. Objects of different mass can have same momentum
      a. Small one going fast = large one going slow
   C. Units $(kg)\cdot\left(\frac{m}{s}\right)$

II. Impulse
   A. = Force x time
   B. Change in momentum created by impulse
      1. Ft = Δmv, and since v is easier to change, usually Ft = mΔv
      2. Units N·s, or $(kg)\cdot\left(\frac{m}{s}\right)$
   C. Force of the change in momentum can be changed by changing time interval of application of force. See ICA for today's class. Click here for link
   D. Reversing velocity (which is a vector with direction and speed) has greater impulse, resulting in greater force.

III. Conservation of momentum
   A. Considering all parts of a system defined as an action-reaction pair, the net momentum is zero
   B. So in action-reaction pairs, $m_1v_1 + m_2v_2 = 0$
   C. Cue ball and 8 ball, marble demonstration, cannon-cannonball problem in class (link here)

IV. Work
   A. = Force x distance
   B. Work is force acting over a distance
   C. Units: N m, or $\text{Joules} = (kg)\cdot\left(\frac{m}{s^2}\right)\cdot m = \frac{kg\cdot m^2}{s^2}$
   D. Change in force or change in distance increases work done
   E. Directly proportional to the change

V. Energy
   A. Property of a system that allows it to do work
   B. Application of force and movement caused by that force
   C. Mechanical energy: two types
      a. Potential energy: waiting to work
         1) Springs, weights above a reference level
         2) Gravitational potential energy = weight x height
            i. E_P = mgh—units:
               a. $E_P = kg \cdot \frac{10 m}{s^2} \cdot m = \frac{kg \cdot m^2}{s^2} = J$
               b. (Joules)
            ii. Gravitational potential energy dependent upon height
      b. Kinetic energy: moving object doing work
         1) Depends on mass and speed
         2) $E_K = \frac{1}{2} m \cdot v^2 = \frac{m \cdot v^2}{2}$
            BE CAREFUL to only square the velocity
         3) When velocity is squared, the energy loses its direction
         4) Kinetic energy is not a vector; it has magnitude but cannot be canceled, (unlike momentum that can be canceled)

VI. Work Energy Theorem
   A. Work = change in Kinetic energy
   B. Energy is conserved—
      1. Gravitational potential energy is changed into kinetic energy of motion as things fall
      2. In system without loss of energy to friction or heat, all of the E_P would change to E_K or back again in pendulum, in roller coaster, in the acrobats Art and Bart from page 75 of textbook.

VII. Power
   A. $= \frac{\text{work done}}{\text{time interval}}$
   B. Units: $= \frac{\text{Joules}}{\text{second}} = \frac{\left(\frac{kg \cdot m^2}{s^2}\right)}{s} = \frac{kg \cdot m^2}{s^3} = \text{watts}$
   C. Power does depend on time interval that work is done.
      1. less time, more power required
      2. more time, less power