Name______________________________________

Date__________ Pd____

Impulsive Force Model (Momentum)

Key Ideas:

momentum = mass x velocity or $p = mv$

Momentum is represented in equations with a lowercase "p"

The units of momentum are kgm/s.

Momentum is a vector - it has both direction and magnitude.

A slow massive object could have the same momentum as a fast, low-mass object.

Impulse is a fancy name for "change in momentum" just as displacement is a fancy name for "change in position"

Impulse = $\Delta(mv) = F_{net}\,\Delta t$ this is called the impulse-momentum theorem

Impulse is also equal to the area under an F_{net} vs. time graph. Momentum is conserved in all collisions as long as the system of analysis is large enough to include all of the objects that exert net forces during the collision.

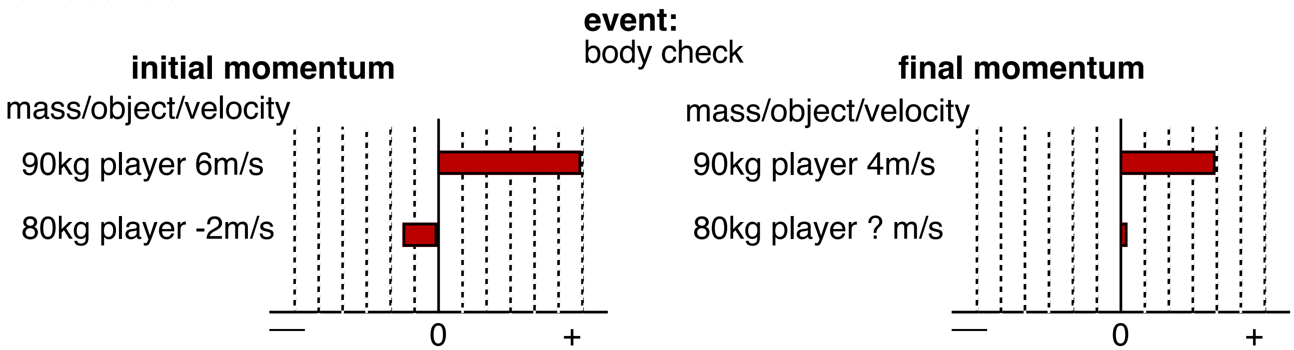
Elastic collisions (think of perfect superballs bouncing off a wall) conserve kinetic energy (no energy is dissipated) and also conserve momentum.

Inelastic collisions (think of a lump of clay hitting and sticking to the wall) dissipate energy. Momentum, however, is still conserved.

Conservation of momentum bar graphs are used to organize information about a collision so that properties such as initial velocity, final velocity or mass of the interacting objects can be found.

1. The first step in using the bar graphs to solve a problem is to identify the event (such as a collision or bounce) that separates the initial situation from the final situation by writing it at the top of the graphs.
2. The objects that are part of the system are listed to the left of each graph. Once you have identified the objects, record their mass and velocity right next to each object's name for both of the final and initial situations. Choose variables for any unknown quantities.
3. Sketch bars representing each object's momentum (mass x velocity). The bars start at the center of the graph and extend to the left or the right according to the direction of the object's motion. Any change in the length of a bar from the initial to final situation represents impulse (change in momentum.)
4. Write the conservation of momentum bar graph below the bars; algebraically solve for the unknown variable; substitute known values with their units; then finish the computations.

For example, a 90kg hockey player makes an illegal check by ramming an 80kg player at 6 m/s and slows to 4m/s after the collision. The 80kg player had been traveling at 2 m/s toward the 90 kg player before the collision. Find the velocity of the 80 kg player after the collision. We will assume that the frictional forces on the players are small enough that the only net force on the players is due to the collision.



Conservation of momentum equation:

$$m_{i90}v_{i90} + m_{i80}v_{i80} = m_{f90}v_{f90} + m_{f80}v_{f80}$$

In this situation we would be careful to indicate velocities to the right as positive and velocities to the left as negative.

Solving for V_{f80}, we find that the final velocity of the 80kg player is +.25 m/s, which is in the opposite direction of the initial motion of the player.