# Force, Impulse, and Momentum

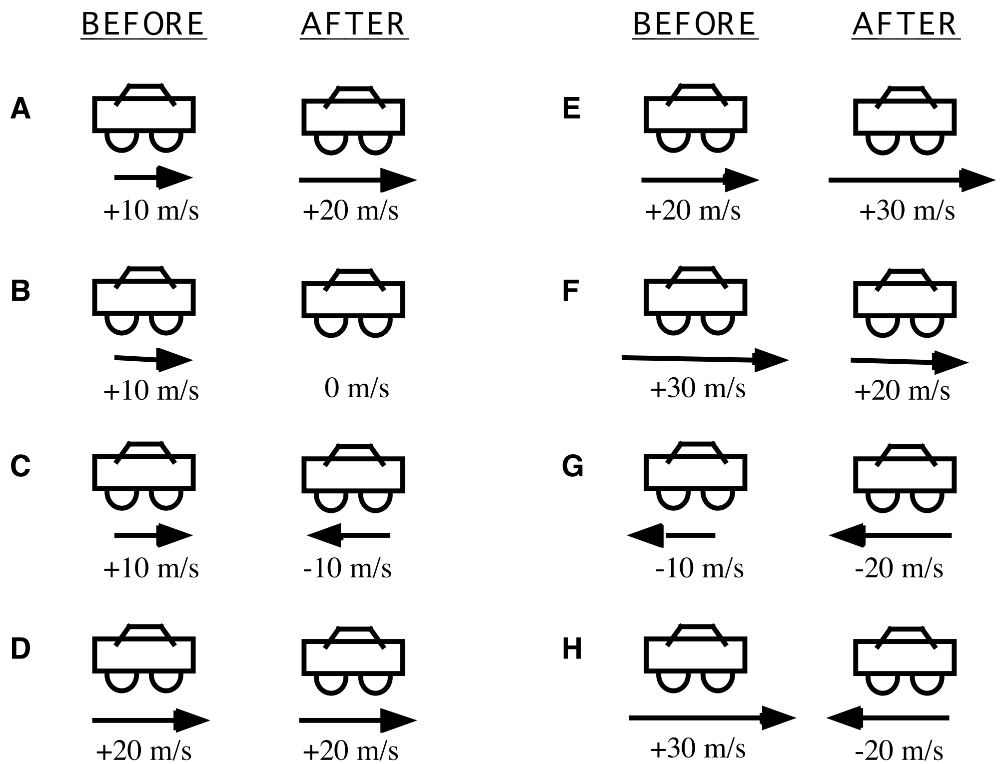
Pre-Class Questions

Problem Set (due next time)
Ch 8 - 1ab, 2ab, 5a, 37, 38

Lecture Outline

1. The Definition of Momentum
2. The Impulse-Momentum Theorem

The eight situations below show *before* and *after* "snapshots" of a car's velocity. Rank these situations, in terms of the change in momentum of these cars, from most positive to most negative. All cars have the same mass. Negative numbers, if any, rank lower than positive ones (-20 m/s < -10 m/s < 0 < 5).




Most Positive 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____ 8_____ Most Negative

Or, the change in momentum of these cars is the same (but not zero) for all of these._____

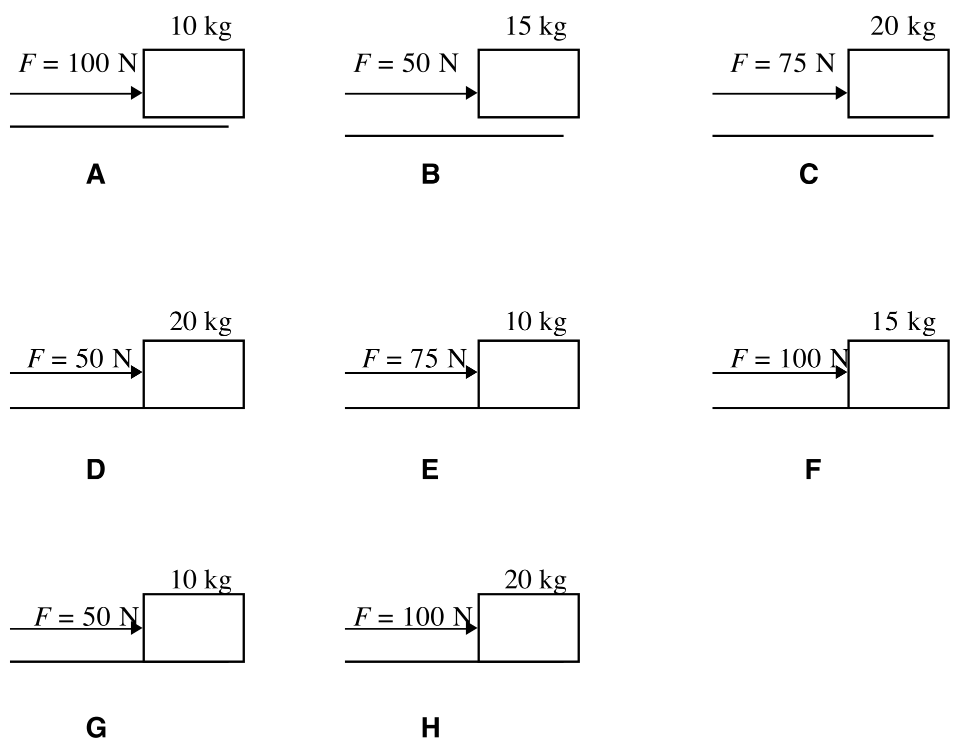
Or, the change in momentum of these cars is zero for all of these.______

Or, it is not possible to determine the change in momentum for all of these cases.______

Please carefully explain your reasoning.

Various similar boxes are being pushed for 10 seconds across a floor by a net horizontal force as shown below. The mass of the boxes and the net horizontal force for each case are given in the indicated figures.

Rank the change in momentum for each box from the greatest change in momentum to the least change in momentum. All boxes have an initial velocity of 0 m/s ( + direction is to the right and - to the left with –4 < -2).




Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ Least

Or, all the changes in momentum are the same.________

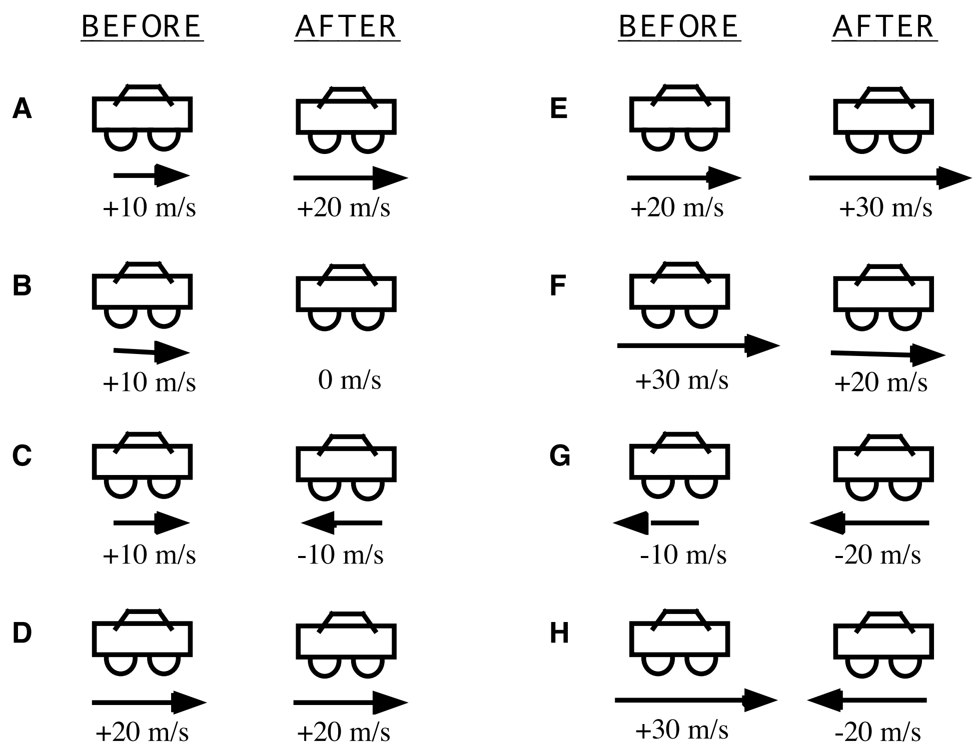
Please carefully explain your reasoning.

*Example 1:A 150g baseball pitched at 30.0m/s is hit straight back at the pitcher at 50.0m/s. The ball is in contact with the bat for 1.00ms. Find (a)the initial momentum, (b)the final momentum and (c)the average force on the ball.*

*Example 2: A 10.0kg cannon ball is launched at a 53° degree angle with a speed of 60.0m/s. Find the x and y components of its momentum.*

| | |
|---|---|
| Impulse-Momentum Theorem $\Delta\vec{p} = \vec{J}$ | Definition of Impulse $\vec{J} \equiv \vec{F}\,\Delta t$ |
| Work-Energy Theorem $\Delta K = W$ | Definition of Work $W \equiv \vec{F}\,\Delta\vec{s}$ |

The eight situations below show *before* and *after* "snapshots" of a car's velocity. Rank these situations, in terms of impulse on these cars, from most positive to most negative, to create these changes in velocity. All cars have the same mass. Negative numbers, if any, rank lower than positive ones (-20 m/s < -10 m/s < 0 < 5).




Most Positive 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ 7_____ 8_____ Most Negative

Or, the impulse on these cars is the same (but not zero) for all of these._________

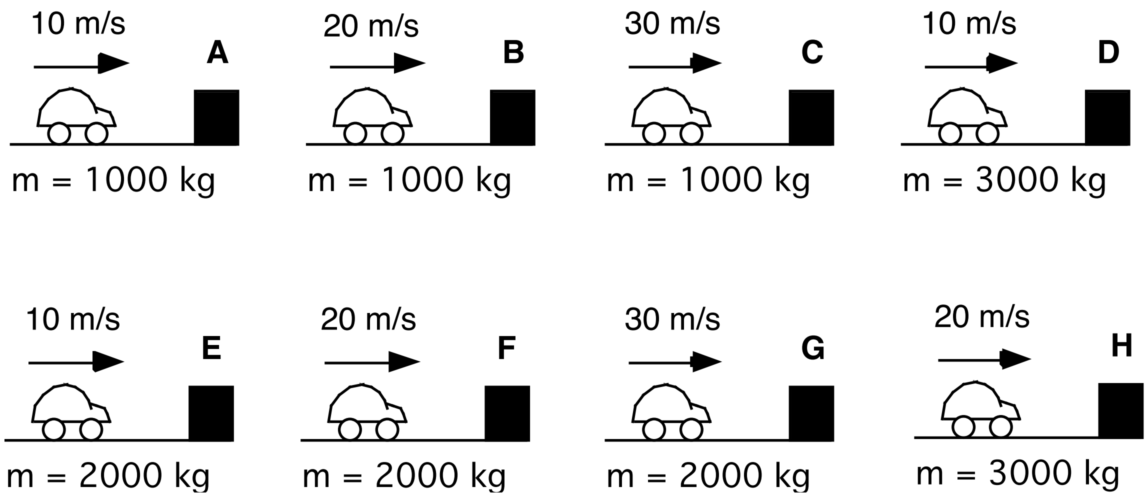
Or, the impulse on these cars is zero for all of these._________

Or, it is not possible to determine the impulse on these cars for all of these._________

Please carefully explain your reasoning.

Shown below are eight cars that are moving along horizontal roads at specified speeds. Also given are the masses of the cars. All of the cars are the same size and shape, but they are carrying loads with different masses. All of these cars are going to be stopped by plowing into identical barriers. All of the cars are going to be stopped by the same constant force by the barrier.

Rank these situations from greatest to least on the basis of the stopping time that will be needed to stop the cars with the same force. That is, put first the car that requires the longest time and put last the car that requires the shortest time to stop the car with the same force.




Longest 1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____ 7 ____ 8 ____ Shortest

Or, all cars require the same time.__________

Please carefully explain your reasoning.

http://www.youtube.com/watch?v=CJHpUO-S0i8

*Example 3: A 50.0g ball moving at 6.00m/s collides with a second ball of equal mass. The first ball comes to rest in 1.00ms. Find (a)the impulse imparted to the first ball, (b)average force acting on the first ball during the collision, (c)the average force acting on the second ball during the collision, (d)the impulse imparted to the second ball and (e)the speed of the second ball after the collision.*

# Lecture 19 - Summary

The Definition of Linear Momentum $\vec{p} \equiv m\vec{v}$

The Original Second Law $\Sigma\vec{F} = \dfrac{\Delta\vec{p}}{\Delta t}$

The Definition of Impulse $\vec{J} \equiv \vec{F}\,\Delta t$

The Impulse-Linear Momentum Theorem $\Delta\vec{p} = \vec{J}$