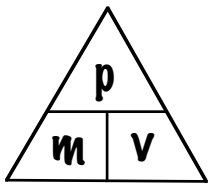
Momentum Notes

Most of us have either bumped into people or have been bumped by people at some point. Sometimes we might cause the other person to be knocked down, or it might be you that was knocked down instead. If someone were to roll a bowling ball and then a golf ball toward you at the same speed, we would find that it requires more effort (force) from us to stop the bowling ball compared to the golf ball.

The reason for these differences in the situations described above, is a property called momentum. Momentum is a property that a moving mass, or object has. It can be calculated by multiplying the mass (in kg) times the velocity (in meters/sec) of the moving object:



Momentum (p) = Mass (m) x Velocity (v)

The resulting units for momentum are:
kilogram • meters/second, kg • m/sec

Sample problems:

#1-Calculate the momentum for a 60 kg student running through the halls at a velocity of 4 m/sec. Include the correct units !

p = mv p = 60 kg • 4 m/sec p = 240 kg • m/sec

#2-Calculate the momentum for a 90 kg student running through the halls at a velocity of 4 m/sec. Include the correct units !

p = mv p = 90 kg • 4 m/sec p = 360 kg • m/sec

From these two examples, we see how the student with more mass has more momentum. Objects with small amounts of mass can still have a lot of momentum, providing they have a high velocity.

#3-Calculate the momentum for a 2 kg rock ejected from a volcanic eruption at a velocity of 800 m/sec. Include the correct units !

$p = mv$ $p = 2\ kg \cdot 800\ m/sec$ $p = 1{,}600\ kg \cdot m/sec$

Conservation of Momentum

The momentum of objects is constant, unless there's a change in either the mass or velocity, or both the mass and velocity change. This is known as the Law of Conservation of Momentum, which says:

> *the total momentum of a group of objects remains constant unless outside forces act on the objects. Momentum can be transferred from one or more objects to other objects, but the total momentum remains the same.*

This is very important in situations that involve collisions between objects, as in auto accidents, games like bowling and pool, and contact sports like football, basketball and soccer.

Momentum can also be transferred from one object to another as in golf, when some of the momentum of a swinging golf club gets transferred to the stationary golf ball, resulting in the golf ball gaining momentum. This causes a change in the velocity of the golf ball. Similar transfers of momentum occur between a tennis racket and tennis ball, a hockey stick and hockey puck, and the arm and hand of a volleyball player and the volleyball it makes contact with.

Unless there is a change in mass of one or more objects during a collision, the only factor that would change is the velocity. Recall that velocity includes the speed and direction of an object. So during some collisions, if there is no change in the speed of an object, there must be a change in the direction of the object or objects. An example of this might be when two opposing soccer players bump into each other while racing to the ball, resulting in a change of direction for each player.