NEWTON'S 3RD LAW AND FRICTION

NEWTON'S 3rd LAW

Any collision reconstructionist will admit that they have had to memorize Newton's Third Law. This law is generally memorized as the following:

"For every action acting on a body, there is an equal and opposite reaction acting on the first body from the second body."

This definition can be confusing during an analysis of motion because it implies that there is an an acting body and a more passive and reacting body.

The language, however, was taken from Newton's work **The Mathematical Principles of Natural Philosophy.** A translation of the work from Albert Motte in the year 1729, quotes Newton as stating:

"To every action there is always and opposed and equal reaction; or, the mutual actions of the two bodies upon each other are always equal and directed to contrary points."

ISAAC NEWTON

Instead of considering Newton's 3rd Law in terms of "action" and "re-action", it is advantageous in understanding a concept to use words more commonly associated to modern language. Is is also

advantageous to use the word "force" as opposed to the word "action". In modern language, Newton's 3rd Law could be worded as follows:

> **If object A exerts a force on object B, then object B exerts a force of equal magnitude but opposite in direction on object A.**
>
> *ISAAC NEWTON*

Although the words are slightly different from those used by Newton, the concept is identical, and is much easier to understand.

Newtons 3rd Law tells us that:

1. Forces always come in pairs
2. Forces involve mutual interaction between 2 objects
3. The forces act on each object in equal magnitude but opposite in direction.

Friction

Now let us examine the implication of Newton's 3rd Law in the context of friction.

Friction: the force that acts between any two surfaces that are in contact and opposing their relative motion.

Friction can best be described as the force that acts between any two surfaces that are in contact and opposing their relative motion. Ultimately, friction arises from the forces between the atoms in the surfaces of both objects.

Also, friction is proportional to the normal force between the surfaces, where the normal force is the force at a 90 degree angle to the surface on which motion is occurring. Mathematically, this relationship is expressed as

$$\vec{F_f} = \mu \vec{N}$$

where $\vec{F_f}$ is the force of friction, μ is the coefficient of friction, and $\vec{N}$ is the normal force (acting at 90 degrees to the path of motion.)

There are two types of friction. Static friction refers to the resistance to motion before the objects are moving relative to one another. It is the measure of force required to set an object in motion. Kinetic friction refers to the resistance to motion once the objects are moving relative to each other at a constant velocity. The static friction is always greater than the kinetic friction because the atoms between both surfaces have had more time to bond.

Modern ABS systems in cars take advantage of the difference between between these two types of friction. The ABS brings the tire instantaneously at rest to maximize the higher co-efficient of friction static friction over that of kinetic friction. As a result, the stoping distance from ABS systems is always shorter than that of a conventional braking system.