Newton's Three Laws of Motion

Newton's First Law of Motion:

I. Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.

Newton's Second Law of Motion:

2 The relationship between an object's mass *m*, its acceleration a, and the applied force *F* is *F* = *ma*. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector

This is the most powerful of Newton's three Laws, because it allows quantitative calculations of dynamics: how do velocities change when forces are applied. Notice the fundamental difference between Newton's 2nd Law and the dynamics of Aristotle: according to Newton, a force causes only a *change in velocity* (an acceleration); it does not maintain the velocity as Aristotle held.

This is sometimes summarized by saying that under Newton, *F* = *ma*, but under Aristotle *F* = *mv*, where *v* is the velocity. Thus, according to Aristotle there is only a velocity if there is a force, but according to Newton an object with a certain velocity maintains that velocity *unless* a force acts on it to cause an acceleration (that is, a change in the velocity). As we have noted earlier in conjunction with the discussion of Galileo, Aristotle's view seems to be more in accord with common sense, but that is because of a failure to appreciate the role played by frictional forces. Once account is taken of *all* forces acting in a given situation it is the dynamics of Galileo and Newton, not of Aristotle, that are found to be in accord with the observations

Newton's Third Law of Motion:

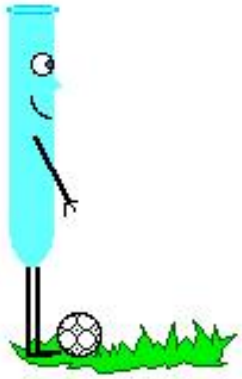
3. For every action there is an equal and opposite reaction.

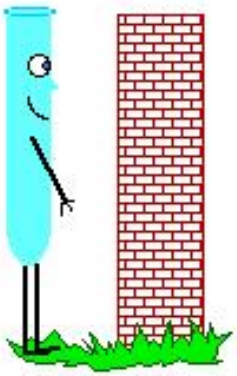
Why use seat belts? Riding in a car you and the car have the same motion. When the brakes are applied, the brakes stop the car. What stops you? Eventually the steering wheel, the dashboard, or the window unless they are replaced by a seat belt, which stops your body. When the accelerator is depressed with the car in gear the motor turns the wheels and the car moves forward. What moves

you forward? As the car moves forward the seatback comes forward, contacts, you and pushes you forward.

(2) While you are riding in the front passenger seat of a car, the driver suddenly turns left. What about you? You continue to move in a straight line until the door to your right, turning left, eventually runs into you. In the car it may appear to you that you slid outward and hit the door.

Everyone unconsciously knows the Second Law. Everyone knows that heavier objects require more force to move the same distance as lighter objects





Is it easier to kick the wall or the ball?

The rocket's action is to push down on the ground with the force of its powerful engines, and the reaction is that the ground pushes the rocket upwards with an equal force.