Newton's Laws of Motion

Newton's first law of motion, sometimes called the law of inertia, was actually adopted by Newton from the work of Galileo. It states that a particle's velocity will not change unless a force is applied to the particle. This means that if a "body" (a collection of particles having appreciable mass) is at rest it remains at rest unless a force is applied. If a body is moving with some velocity, it will continue to move with the same velocity unless a force is applied. The first law is really just a qualitative statement about the persistence of motion.

Newton's second law gets into a quantitative relationship between forces and motion. For this we need to revisit the rate of change idea. We defined velocity as the rate of change of position, a small displacement divided by the corresponding change in time, as $\vec{v} = d\vec{r}/dt$. The velocity vector itself may change over time so it too has a rate of change. That rate of change of velocity is called "acceleration". The acceleration of a body is the change in velocity divided by the corresponding change in time, as $\vec{a} = d\vec{v}/dt$. We have no single word analogous to displacement, describing the change in velocity.

The second law states that the acceleration of a body is proportional to the force on it. This is consistent with our experience that the harder we push on a moveable body, the quicker its speed changes. The second law goes on to state that the constant of proportionality between the force and the acceleration is the "mass" of the body. In the form of an equation the second law reads $\vec{F} = m\vec{a}$, where $\vec{F}$ is the force vector, m is the scalar mass, and $\vec{a}$ is the acceleration vector. The mass may be considered the property of a body that determines its resistance to changing its velocity.

We are using the kilogram as the unit of mass. The unit of length is the meter, so displacement is in meters. Velocity is calculated as displacement divided by time so its units are meters per second. Acceleration is calculated as velocity divided by time so its units are meters per second per second, or meters per second squared. The force sufficient to accelerate one kilogram by one meter per second squared is called one Newton, in honor of the old gentleman himself.

You may have observed that the first law is contained in the second as the special case where force and therefore acceleration are zero.[1]

Newton's third law addresses the nature of forces. The implicit assumption is that a force is simply a manifestation of the interaction between a pair of bodies. You might say there can not be a pushee without a pusher. The third law states that the force resulting from the interaction of two bodies acts with equal magnitude on both of them and in opposite directions. For every action, there is an equal and opposite reaction.

These three laws of nature credited to Newton are not all there are but they are enough to allow us to get started in building and analyzing mathematical models of some dynamical systems.

from the article given in `http://www.mcasco.com/p1nlm.html`

[1] Comment by the teacher: This statement is not right. The first law is necessary since it gives the definition of the inertial frame.