6.3: Acceleration, Force, and Mass

We have a good intuitive feel for the concepts of force and mass because they are very much a part of our everyday experience. We think of force as how hard we push on something. Mass is the resistance of an object to acceleration if it is otherwise free to move. Thus, pushing on a bicycle on a smooth, level road causes it to accelerate more readily than pushing on a car. We say that the car has greater mass. We can summarize this relationship with Newton's second law

$$F = ma \tag{6.3.1}$$

where F is the total force on an object, m is its mass, and a is the acceleration resulting from the force.

Three provisos apply to equation (6.3.1). First, it only makes sense in unmodified form when the velocity of the object is much less than the speed of light. For relativistic velocities it is best to write this equation in a slightly different form which we introduce later. Second, the force must be the total force, including all frictional and other incidental forces which might otherwise be neglected by an uncritical observer. Third, it only works in a reference frame which itself is unaccelerated, i.e., an *inertial reference frame*. We deal below with accelerated reference frames.