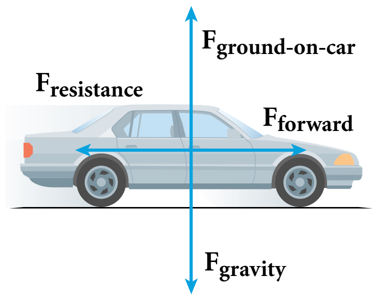

Figure 5
Although several forces are acting on this car, the vector sum of the forces is zero, so the car moves at a constant velocity.

net force

a single force whose external effects on a rigid body are the same as the effects of several actual forces acting on the body

The sum of forces acting on an object is the net force

Consider a car traveling at a constant velocity. Newton's first law tells us that the net external force on the car must be equal to zero. However, **Figure 5** shows that many forces act on a car in motion. The vector $\mathbf{F}_{\mathbf{forward}}$ represents the forward force of the road on the tires. The vector $\mathbf{F}_{\mathbf{resistance}}$, which acts in the opposite direction, is due partly to friction between the road surface and tires and is due partly to air resistance. The vector $\mathbf{F}_{\mathbf{gravity}}$ represents the downward gravitational force on the car, and the vector $\mathbf{F}_{\mathbf{ground\text{-}on\text{-}car}}$ represents the upward force that the road exerts on the car.

To understand how a car under the influence of so many forces can maintain a constant velocity, you must understand the distinction between external force and net external force. An *external force* is a single force that acts on an object as a result of the interaction between the object and its environment. All four forces in **Figure 5** are external forces acting on the car. The **net force** is the vector sum of all forces acting on an object.

When all external forces acting on an object are known, the net force can be found by using the methods for finding resultant vectors. The net force is equivalent to the one force that would produce the same effect on the object that all of the external forces combined would. Although four forces are acting on the car in **Figure 5,** the car will maintain its constant velocity as long as the vector sum of these forces is equal to zero.

Mass is a measure of inertia

Imagine a basketball and a bowling ball at rest side by side on the ground. Newton's first law states that both balls remain at rest as long as no net external force acts on them. Now, imagine supplying a net force by pushing each ball. If the two are pushed with equal force, the basketball will accelerate much more than the bowling ball. The bowling ball experiences a smaller acceleration because it has more inertia than the basketball does.

As the example of the bowling ball and the basketball shows, the inertia of an object is proportional to the object's mass. The greater the mass of a body, the less the body accelerates under an applied force. Similarly, a light object undergoes a larger acceleration than does a heavy object under the same force. Therefore, mass, which is a measure of the amount of matter in an object, is also a measure of the inertia of an object.

Quick Lab

Inertia

MATERIALS LIST

- **skateboard or cart**
- **toy balls with various masses**

SAFETY

Perform this experiment away from walls and furniture that can be damaged.

Place a small ball on the rear end of a skateboard or cart. Push the skateboard across the floor and into a wall. You may need to hold the ball in place while pushing the skateboard up to speed or accelerate the skateboard slowly so that friction holds the ball in place. Observe what happens to the ball when the skateboard hits the wall. Can you explain your observation in terms of inertia? Repeat the procedure using balls with different masses, and compare the results.