FIGURE 2.19
When you flip a coin in a high-speed airplane, it behaves as if the airplane were at rest. The coin keeps up with you—inertia in action!

its initial sideways motion of 30 kilometers per second remains unchanged. It catches the worm, quite unaffected by the motion of its total environment.

Stand next to a wall. Jump up so that your feet are no longer in contact with the floor. Does the 30-kilometer-per-second wall slam into you? It doesn't, because you are also traveling at 30 kilometers per second—before, during, and after your jump. The 30 kilometers per second is the speed of Earth relative to the Sun, not the speed of the wall relative to you.

People 400 years ago had difficulty with ideas like these, not only because they failed to acknowledge the concept of inertia but because they were not accustomed to moving in high-speed vehicles. Slow, bumpy rides in horse-drawn carriages did not lend themselves to experiments that would reveal the effect of inertia. Today we flip a coin in a high-speed car, bus, or plane, and we catch the vertically moving coin as we would if the vehicle were at rest. We see evidence for the law of inertia when the horizontal motion of the coin before, during, and after the catch is the same. The coin keeps up with us. The vertical force of gravity affects only the vertical motion of the coin.

Our notions of motion today are very different from those of our ancestors. Aristotle did not recognize the idea of inertia because he did not see that all moving things follow the same rules. He imagined that the rules for motion in the heavens were very different from the rules for motion on Earth. He saw vertical motion as natural but horizontal motion as unnatural, requiring a sustained force. Galileo and Newton, on the other hand, saw that all moving things follow the same rules. To them, moving things require *no* force to keep moving if there are no opposing forces, such as friction. We can only wonder how differently science might have progressed if Aristotle had recognized the unity of all kinds of motion.

For instructor-assigned homework, go to www.masteringphysics.com MP

SUMMARY OF TERMS (KNOWLEDGE)

Inertia The property of things to resist changes in motion.

Newton's first law of motion (the law of inertia) Every object continues in a state of rest or of uniform speed in a straight line unless acted on by a nonzero net force.

Force In the simplest sense, a push or a pull.

Net force The vector sum of forces that act on an object.

Vector An arrow drawn to scale used to represent a vector quantity.

Vector quantity A quantity that has both magnitude and direction, such as force.

Scalar quantity A quantity that has magnitude but not direction, such as mass and volume.

Resultant The net result of a combination of two or more vectors.

Mechanical equilibrium The state of an object or system of objects for which there are no changes in motion. In accord with Newton's first law, if an object is at rest, the state of rest persists. If an object is moving, its motion continues without change.

Equilibrium rule For any object or system of objects in equilibrium, the sum of the forces acting equals zero. In equation form, $\sum \boldsymbol{F} = 0$.

READING CHECK QUESTIONS (COMPREHENSION)

Most chapters in this book conclude with a set of questions, activities, problems, and exercises. ***Reading Check Questions*** *are designed to help you comprehend ideas and grasp the essentials of the chapter material. You'll notice that answers to the questions can be found within the chapters.* ***Think and Do*** *activities focus on hands-on applications (there are none in this chapter). Simple* ***Plug and Chug*** *one-step problems are for equation familiarization (there are none in this chapter). Your math skills are applied to* ***Think and Solve*** *problems, followed by* ***Think and Rank*** *tasks that prompt you to analyze and compare the magnitudes of various quantities. The most important end-of-chapter items are* ***Think and Explain*** *exercises, which stress synthesizing material and focus on thinking rather than mere recall of information. Unless you cover only a few chapters in your course, you will likely be expected to tackle only a few of these exercises for each chapter.* ***Think and Discuss*** *questions follow and, as the name implies, are meant to elicit discussions with your classmates. Put on your thinking cap and begin!*