CHAPTER 5

Newton's Laws

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How many times have you heard the saying, "It all depends on your perspective"? The photographers who took the two pictures of the roller coaster shown here certainly had different perspectives. When you are on a roller coaster, the world looks and feels very different than it does when you are observing the motion from a distance. Now imagine doing a physics experiment from these two perspectives, studying the motion of a pendulum, for example. Your results would definitely depend on your perspective or frame of reference. You can describe motion from any frame of reference, but some frames of reference simplify the process of describing the motion and the laws that determine that motion.

In this chapter, you will learn about and apply Newton's laws of motion. You will discover that an appropriate choice of a reference frame is critical in problem solving. You will also find that Newton's laws can be expressed in several different forms. One form is often more appropriate for solving a particular type of problem than another. Finally, you will discover that a variety of problems require a combination of Newton's laws and the kinematic equations.

MULTI LAB

Thinking Physics

TARGET SKILLS

- Predicting
- Identifying variables
- Analyzing and interpreting

Suspended Spring

Tape a plastic cup to one end of a short section of a large-diameter spring, such as a Slinky™. Hold the other end of the spring high enough so that the plastic cup is at least 1 m above the floor. Before you release the spring, predict the exact motion of the cup from the instant that it is released until the moment that it hits the floor. While your partner watches the cup closely from a kneeling position, release the top of the spring. Observe the motion of the cup.

Analyze and Conclude

1. Describe the motion of the cup and the lower end of the spring. Compare the motion to your prediction and describe any differences.
2. Is it possible for any unsupported object to be suspended in midair for any length of time? Create a detailed explanation to account for the behaviour of the cup at the moment at which you released the top of the spring.
3. Athletes and dancers sometimes seem to be momentarily suspended in the air. How might the motion of these athletes be related to the spring's movement in this lab?

Thought Experiments

Without discussing the following questions with anyone else, write down your answers.

1. Student A and Student B sit in identical office chairs facing each other, as illustrated. Student A, who is heavier than Student B, suddenly pushes with his feet, causing both chairs to move. Which of the following occurs?

   (a) Neither student applies a force to the other.

   (b) A exerts a force that is applied to B, but A experiences no force.

   (c) Each student applies a force to the other, but A exerts the larger force.

   (d) The students exert the same amount of force on each other.

2. A golf pro drives a ball through the air. What force(s) is/are acting on the golf ball for the *entirety* of its flight?

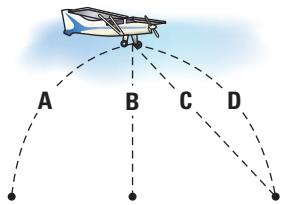
   (a) force of gravity only

   (b) force of gravity and the force of the "hit"

   (c) force of gravity and the force of air resistance

   (d) force of gravity, the force of the "hit," and the force of air resistance

3. A photographer accidentally drops a camera out of a small airplane as it flies horizontally. As seen from the ground, which path would the camera most closely follow as it fell?



Analyze and Conclude

Tally the class results. As a class, discuss the answers to the questions.