Figure 3.1 A plane slows down as it comes in for landing in St. Maarten. Its acceleration is in the opposite direction of its velocity. (Steve Conry, Flickr)

Chapter Outline

3.1 Acceleration

3.2 Representing Acceleration with Equations and Graphs

Introduction

Teacher Support

Teacher Support Ask the students to give definitions of acceleration. Dispel any misconceptions such as, *acceleration means very high speed or going faster*. Emphasize that acceleration does not just indicate speeding up; acceleration also includes slowing down or changing direction. Explain that acceleration is the change in either the magnitude or direction of velocity, or both. Have students list the objects in the opening image that are moving. Then ask which are definitely accelerating and which might be accelerating. Review the use of $+$ and $-$ signs as they relate to acceleration and velocity. Explain that, when studying motion, these symbols are often used to indicate the direction of motion. The $+$ symbol typically represents motion that is to the right or upward, whereas $-$ typically represents motion that is to the left or downward.

You may have heard the term *accelerator*, referring to the gas pedal in a car. When the gas pedal is pushed down, the flow of gasoline to the engine increases, which increases the car's velocity. Pushing on the gas pedal results in acceleration because the velocity of the car increases, and acceleration is defined as

a change in velocity. You need two quantities to define velocity: a speed and a direction. Changing either of these quantities, or both together, changes the velocity. You may be surprised to learn that pushing on the brake pedal or turning the steering wheel also causes acceleration. The first reduces the *speed* and so changes the velocity, and the second changes the *direction* and also changes the velocity.

In fact, any change in velocity—whether positive, negative, directional, or any combination of these—is called an acceleration in physics. The plane in the picture is said to be accelerating because its velocity is decreasing as it prepares to land. To begin our study of acceleration, we need to have a clear understanding of what acceleration means.

Teacher Support

Teacher Support Before students begin this chapter, it is useful to review the following concepts:

- Significant figures—demonstrate how to obtain the proper number of significant figures when adding and multiplying
- Scientific notation and how it expresses significant figures
- Converting units—demonstrate how to convert from km/h to m/s; show how units cancel in calculations
- Calculating average—demonstrate how to calculate the average of two numbers
- Commonly used terms—explain that *constant* means *unchanging*, so constant acceleration refers to acceleration that is not changing in time
- Explain that *initial* means *starting* or *beginning*, so the initial time is the time at which the action of interest begins
- Explain that an object that is not moving is often described in physics as being *at rest*
- Review conventions of coordinate systems
- Review kinematics concepts introduced earlier: vectors, displacement, velocity, and speed