SECTION 1

Introduction to Vectors

SECTION OBJECTIVES

- Distinguish between a scalar and a vector.
- Add and subtract vectors by using the graphical method.
- Multiply and divide vectors by scalars.

SCALARS AND VECTORS

In the chapter "Motion in One Dimension," our discussion of motion was limited to two directions, forward and backward. Mathematically, we described these directions of motion with a positive or negative sign. That method works only for motion in a straight line. This chapter explains a method of describing the motion of objects that do not travel along a straight line.

Vectors indicate direction; scalars do not

scalar

a physical quantity that has magnitude but no direction

vector

a physical quantity that has both magnitude and direction

Each of the physical quantities encountered in this book can be categorized as either a scalar quantity or a vector quantity. A **scalar** is a quantity that has magnitude but no direction. Examples of scalar quantities are speed, volume, and the number of pages in this textbook. A **vector** is a physical quantity that has both direction and magnitude.

As we look back to the chapter "Motion in One Dimension," we can see that displacement is an example of a vector quantity. An airline pilot planning a trip must know exactly how far and which way to fly. Velocity is also a vector quantity. If we wish to describe the velocity of a bird, we must specify both its speed (say, 3.5 m/s) and the direction in which the bird is flying (say, northeast). Another example of a vector quantity is acceleration.

Figure 1
The lengths of the vector arrows represent the magnitudes of these two soccer players' velocities.

Vectors are represented by boldface symbols

In physics, quantities are often represented by symbols, such as t for time. To help you keep track of which symbols represent vector quantities and which are used to indicate scalar quantities, this book will use **boldface** type to indicate vector quantities. Scalar quantities will be in *italics*. For example, the speed of a bird is written as $v = 3.5$ m/s. But a velocity, which includes a direction, is written as $\mathbf{v} = 3.5$ m/s to the northeast. When writing a vector on your paper, you can distinguish it from a scalar by drawing an arrow above the abbreviation for a quantity, such as $\vec{v} = 3.5$ m/s to the northeast.

One way to keep track of vectors and their directions is to use diagrams. In diagrams, vectors are shown as arrows that point in the direction of the vector. The length of a vector arrow in a diagram is proportional to the vector's magnitude. For example, in **Figure 1** the arrows represent the velocities of the two soccer players running toward the soccer ball.