11.1 Distance and Displacement

Reading Focus

Key Concepts

- What is needed to describe motion completely?
- How are distance and displacement different?
- How do you add displacements ?

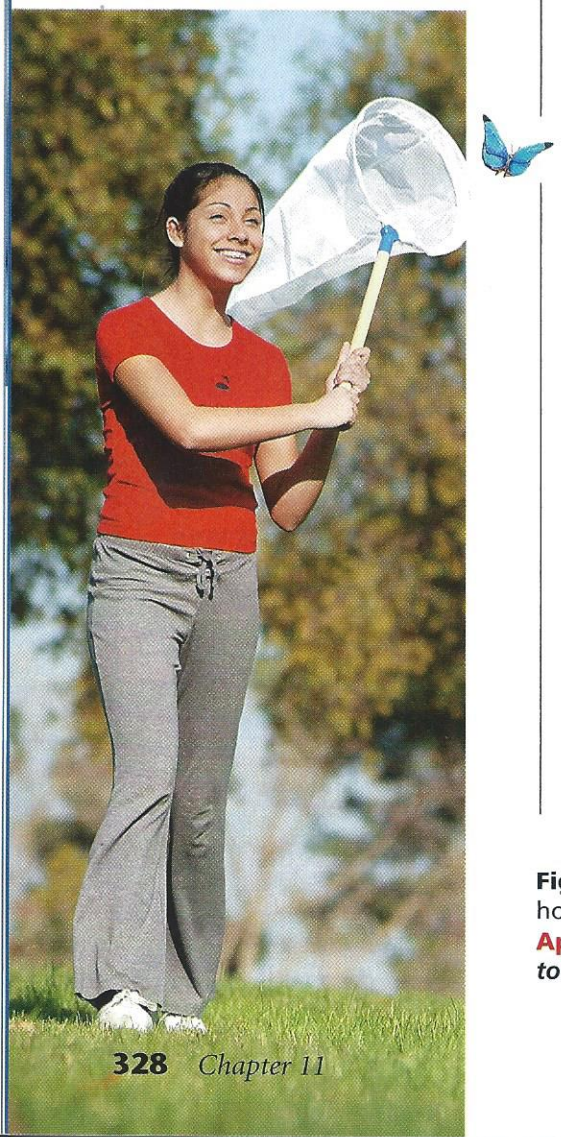
Vocabulary

- frame of reference
- relative motion
- distance
- vector
- resultant vector

Reading Strategy

Predicting Copy the table below and write a definition for *frame of reference* in your own words. After you read the section, compare your definition to the scientific definition and explain why the frame of reference is important.

Frame of reference probably means	Frame of reference actually means
a. ?	b. ?



On a spring day a butterfly flutters past. First it flies quickly, then slowly, and then it pauses to drink nectar from a flower. The butterfly's path involves a great deal of motion.

How fast is the butterfly moving? Is it flying toward the flower or away from it? These are the kinds of questions you must answer to describe the butterfly's motion. To describe motion, you must state the direction the object is moving as well as how fast the object is moving. You must also tell its location at a certain time.

Choosing a Frame of Reference

How fast is the butterfly in Figure 1 moving? Remember that the butterfly is moving on Earth, but Earth itself is moving as it spins on its axis and revolves around the sun. If you consider this motion, the butterfly is moving very, very fast!

To describe motion accurately and completely, a frame of reference is necessary. The necessary ingredient of a description of motion—a **frame of reference**—is a system of objects that are not moving with respect to one another. The answer to "How fast is the butterfly moving?" depends on which frame of reference you use to measure motion. How do you decide which frame of reference to use when describing the butterfly's movement?

Figure 1 You must choose a frame of reference to tell how fast the butterfly is moving.
Applying Concepts *Identify a good frame of reference to use when describing the butterfly's motion.*

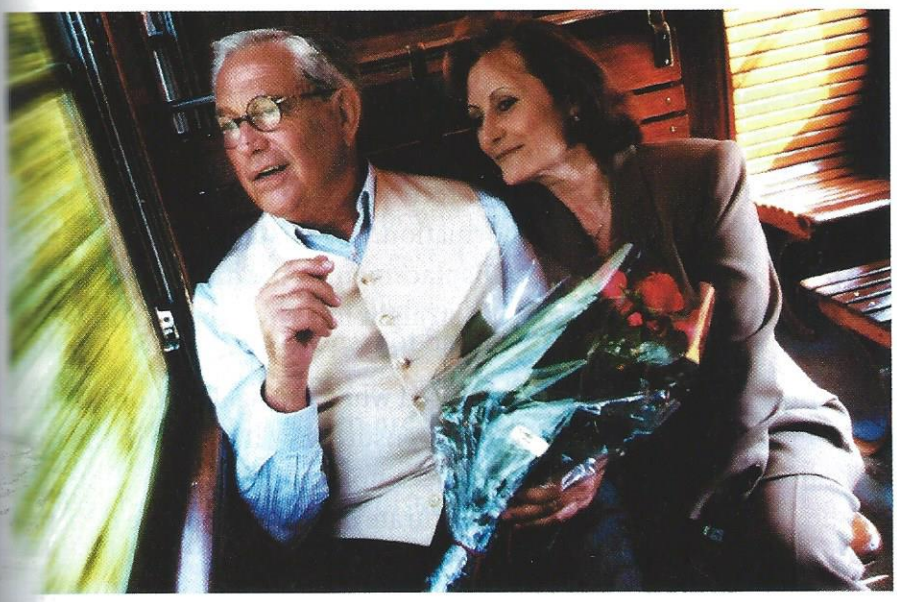


Figure 2 To someone riding on a speeding train, others on the train don't seem to be moving.

How Fast Are You Moving? How fast are the train passengers in Figure 2 moving? There are many correct answers because their motion is relative. This means it depends on the frame of reference you choose to measure their motion. **Relative motion** is movement in relation to a frame of reference. For example, as the train moves past a platform, people standing on the platform will see those on the train speeding by. But when the people on the train look at one another, they don't seem to be moving at all.

Which Frame Should You Choose? When you sit on a train and look out a window, a treetop may help you see how fast you are moving relative to the ground. But suppose you get up and walk toward the rear of the train. Looking at a seat or the floor may tell you how fast you are walking relative to the train. However, it doesn't tell you how fast you are moving relative to the ground outside. Choosing a meaningful frame of reference allows you to describe motion in a clear and relevant manner.

Measuring Distance

Distance is the length of a path between two points. When an object moves in a straight line, the distance is the length of the line connecting the object's starting point and its ending point.

It is helpful to express distances in units that are best suited to the motion you are studying. The SI unit for measuring distance is the meter (m). For very large distances, it is more common to make measurements in kilometers (km). One kilometer equals 1000 meters. For instance, it's easier to say that the Mississippi River has a length of 3780 kilometers than 3,780,000 meters. Distances that are smaller than a meter are measured in centimeters (cm). One centimeter is one hundredth of a meter. You might describe the distance a marble rolls, for example, as 6 centimeters rather than 0.06 meter.