CHAPTER 3

Analyzing Motion

CHAPTER CONTENTS

Why do some people find water skiing so exhilarating? Certainly, travelling at high speeds is thrilling, but for many, the challenge of sports has another dimension — the desire to gain and maintain control over the motion of your body or that of the vehicle you are operating.

Although a water-skier depends on the towboat for propulsion, the skier can travel in a different direction and at a different speed than the boat. Similarly, windsurfers rely on the wind, but learn how to harness its energy to sail in directions other than that of the wind. The challenge is to understand what affects the direction of the motion and use that knowledge to create the desired motion. The water-skier and windsurfer develop a sense or "feel" for the techniques that they need to control their motion. However, to put a satellite into orbit or to build a guidance system for a rocket, the knowledge of motion and its causes must be much more precise and based on calculations.

You began your study of motion in the last chapter by developing the concepts of displacement, velocity, and acceleration. You performed detailed analyses of these quantities in one dimension, or a straight line. In this chapter, you will expand your knowledge to two dimensions and learn more about the vector nature of the quantities that describe motion.

MULTI LAB

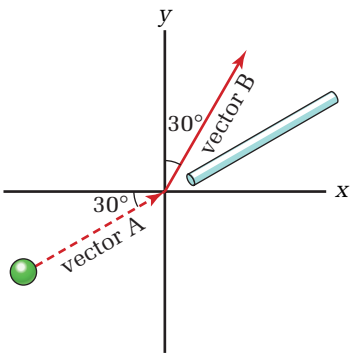
Pushed Around

TARGET SKILLS

- **Identifying variables**
- **Analyzing and interpreting**

Changing Course

How is the *direction of acceleration* related to the *change in velocity* of a marble rolling in a plane? Try this activity to explore the answer to this question. Draw an *x*–*y*-coordinate system on a piece of easel paper, and place the paper flat on your desk or lab bench. Draw vectors A and B on your chart, as shown in the diagram.



Roll a marble so that it travels along vector A at a reasonably slow speed. As the marble approaches the origin, gently blow on the marble through a straw, causing the marble to leave the origin, travelling along vector B. Practise this procedure until you have perfected your technique. On the easel paper, sketch the direction in which you needed to blow in order to create the desired change in direction of the motion of the marble. Repeat the procedure several more times with other pairs of vectors. Predict the direction you will need to blow to cause the change in velocity. Test your predictions.

Analyze and Conclude

1. Analyze your sketches and look for a pattern that relates the direction of the push you exerted on the marble by blowing on it and the change in direction of the motion of the marble.
2. Describe the marble's motion by using the concepts of constant velocity, changes in velocity, and acceleration. Explain your reasoning.

Watch Those Curves!

Draw a curved line on the easel paper. This time, investigate how you can cause the marble to follow the curve. Set the marble rolling toward the curve and then either blow or tap on it gently so that the marble follows the curved line. Carefully describe what you must do to keep the marble curving.

Analyze and Conclude

1. Describe the marble's *speed* throughout its journey along the curved path.
2. Does the marble maintain a *constant velocity* during this experiment? Explain your reasoning.
3. Summarize the pattern you have found between the direction in which you blow or tap on the marble and its change in velocity as it follows the curve.