SECTION 1

Circular Motion

SECTION OBJECTIVES

- **Solve problems involving centripetal acceleration.**
- **Solve problems involving centripetal force.**
- **Explain how the apparent existence of an outward force in circular motion can be explained as inertia resisting the centripetal force.**

CENTRIPETAL ACCELERATION

Consider a spinning Ferris wheel, as shown in **Figure 1.** The cars on the rotating Ferris wheel are said to be in *circular motion.* Any object that revolves about a single axis undergoes circular motion. The line about which the rotation occurs is called the *axis of rotation.* In this case, it is a line perpendicular to the side of the Ferris wheel and passing through the wheel's center.

Tangential speed depends on distance

Tangential speed (v_t) can be used to describe the speed of an object in circular motion. The tangential speed of a car on the Ferris wheel is the car's speed along an imaginary line drawn tangent to the car's circular path. This definition can be applied to any object moving in circular motion. When the tangential speed is constant, the motion is described as *uniform circular motion.*

The tangential speed depends on the distance from the object to the center of the circular path. For example, consider a pair of horses side-by-side on a carousel. Each completes one full circle in the same time period, but the horse on the outside covers more distance than the inside horse does, so the outside horse has a greater tangential speed.

ADVANCED TOPICS

See "Tangential Speed and Acceleration" in **Appendix J: Advanced Topics** to learn more about tangential speed, and to be introduced to the concept of tangential acceleration.

Centripetal acceleration is due to a change in direction

Suppose a car on a Ferris wheel is moving at a constant speed around the wheel. Even though the tangential speed is constant, the car still has an acceleration. To see why, consider the equation that defines acceleration:

$$\mathbf{a} = \frac{\mathbf{v_f} - \mathbf{v_i}}{t_f - t_i}$$

Acceleration depends on a change in the velocity. Because velocity is a vector, acceleration can be produced by a change in the *magnitude* of the velocity, a change in the *direction* of the velocity, or both.

Figure 1
Any point on a Ferris wheel spinning about a fixed axis undergoes circular motion.