The acceleration of a Ferris wheel car moving in a circular path and at constant speed is due to a change in direction. An acceleration of this nature is called a **centripetal acceleration.** The magnitude of a centripetal acceleration is given by the following equation:

centripetal acceleration

the acceleration directed toward the center of a circular path

CENTRIPETAL ACCELERATION

$$a_c = \frac{v_t^2}{r}$$

$$\text{centripetal acceleration} = \frac{(\text{tangential speed})^2}{\text{radius of circular path}}$$

What is the direction of centripetal acceleration? To answer this question, consider **Figure 2(a).** At time t_i, an object is at point A and has tangential velocity $\mathbf{v_i}$. At time t_f, the object is at point B and has tangential velocity $\mathbf{v_f}$. Assume that $\mathbf{v_i}$ and $\mathbf{v_f}$ differ in direction but have the same magnitudes.

The change in velocity ($\Delta\mathbf{v} = \mathbf{v_f} - \mathbf{v_i}$) can be determined graphically, as shown by the vector triangle in **Figure 2(b).** Note that when Δt is very small, $\mathbf{v_f}$ will be almost parallel to $\mathbf{v_i}$. The vector $\Delta\mathbf{v}$ will be approximately perpendicular to $\mathbf{v_f}$ and $\mathbf{v_i}$ and will be pointing toward the center of the circle. Because the acceleration is in the direction of $\Delta\mathbf{v}$, the acceleration will also be directed toward the center of the circle. Centripetal acceleration is always directed toward the center of a circle. In fact, the word *centripetal* means "center seeking." This is the reason that the acceleration of an object in uniform circular motion is called *centripetal acceleration.*

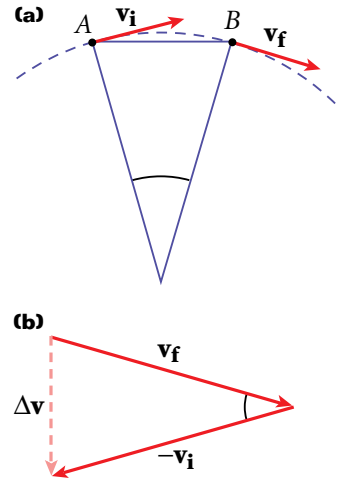

Figure 2
(a) As the particle moves from A to B, the direction of the particle's velocity vector changes. **(b)** For short time intervals, $\Delta\mathbf{v}$ is directed toward the center of the circle.

SAMPLE PROBLEM A

Centripetal Acceleration

PROBLEM

A test car moves at a constant speed around a circular track. If the car is 48.2 m from the track's center and has a centripetal acceleration of 8.05 m/s^2, what is the car's tangential speed?

SOLUTION

Given: $r = 48.2\ \text{m}$ $a_c = 8.05\ \text{m/s}^2$

Unknown: $v_t = ?$

Use the centripetal acceleration equation, and rearrange to solve for v_t.

$$a_c = \frac{v_t^2}{r}$$

$$v_t = \sqrt{a_c r} = \sqrt{(8.05\ \text{m/s}^2)(48.2\ \text{m})}$$

$$\boxed{v_t = 19.7\ \text{m/s}}$$