This equation is valid only when ω is measured in radians per unit of time. Other measures of angular speed must not be used in this equation.

Tangential acceleration

If a carousel speeds up, the horses on it experience an angular acceleration. The linear acceleration related to this angular acceleration is tangent to the circular path and is called the **tangential acceleration.** If an object rotating about a fixed axis changes its angular speed by $\Delta\omega$ in the interval Δt, the tangential speed of a point on the object has changed by the amount Δv_t. Using the equation for tangential speed and dividing by Δt results in the following:

$$\Delta v_t = r\Delta\omega$$

$$\frac{\Delta v_t}{\Delta t} = r\frac{\Delta\omega}{\Delta t}$$

If the time interval Δt is very small, then the left side of this relationship gives the tangential acceleration of the point. The angular speed divided by the time interval on the right side is the angular acceleration. Thus, the tangential acceleration (a_t) of a point on a rotating object is given by the following relationship:

TANGENTIAL ACCELERATION

$$a_t = r\alpha$$

tangential acceleration = distance from axis × angular acceleration

The angular acceleration in this equation refers to the instantaneous angular acceleration. This equation must use the unit radians to be valid. In SI, angular acceleration is expressed as radians per second per second.

Finding total acceleration

Recall that any object moving in a circle has a centripetal acceleration, as discussed in the chapter on circular motion. When both components of acceleration exist simultaneously, the tangential acceleration is tangent to the circular path and the centripetal acceleration points toward the center of the circular path. Because these components of acceleration are perpendicular to each other, the magnitude of the *total acceleration* can be found using the Pythagorean theorem, as follows:

$$a_{total} = \sqrt{a_t^2 + a_c^2}$$

The direction of the total acceleration, as shown in **Figure 2,** depends on the magnitude of each component of acceleration and can be found using the inverse of the tangent function. Note that when there is a tangential acceleration, the tangential speed is changing, and thus this situation is *not* an example of uniform circular motion.

extension

Practice Problems

Visit go.hrw.com to find sample and practice problems for tangential speed and tangential acceleration.

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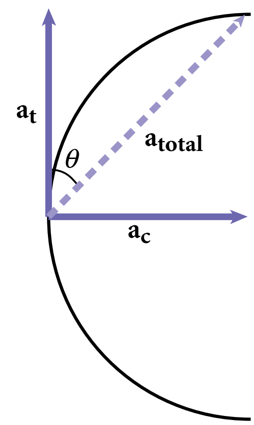

Figure 2
The direction of the total acceleration of a rotating object can be found using the inverse tangent function.