The relationships between the signs of angular displacement, angular velocity, and angular acceleration are similar to those of the related linear quantities. As discussed earlier, by convention, angular displacement is positive when an object rotates counterclockwise and negative when an object rotates clockwise. Thus, by definition, angular velocity is also positive when an object rotates counterclockwise and negative when an object rotates clockwise. Angular acceleration has the same sign as the angular velocity when it increases the magnitude of the angular velocity, and the opposite sign when it decreases the magnitude.

If a point on the rim of a bicycle wheel had an angular velocity greater than a point nearer the center, the shape of the wheel would be changing. Thus, for a rotating object to remain rigid, as does a bicycle wheel or a Ferris wheel, every portion of the object must have the same angular velocity and the same angular acceleration. This fact is precisely what makes angular velocity and angular acceleration so useful for describing rotational motion.

Kinematic equations for constant angular acceleration

All of the equations for rotational motion defined thus far are analogous to the linear quantities defined in the chapter "Motion in One Dimension." For example, consider the following two equations:

$$\omega_{avg} = \frac{\theta_f - \theta_i}{t_f - t_i} = \frac{\Delta\theta}{\Delta t} \qquad v_{avg} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$

The equations are similar, with θ replacing x and ω replacing v. The correlations between angular and linear variables are shown in **Table 1.**

In light of the similarities between variables in linear motion and those in rotational motion, it should be no surprise that the kinematic equations of rotational motion are similar to the linear kinematic equations. The equations of rotational kinematics under constant angular acceleration are summarized in **Table 2,** along with the corresponding equations for linear motion under constant acceleration. The rotational motion equations apply only for objects rotating about a fixed axis with constant angular acceleration.

Table 2 Rotational and Linear Kinematic Equations

Rotational motion with constant angular acceleration	Linear motion with constant acceleration
$\omega_f = \omega_i + \alpha\Delta t$	$v_f = v_i + a\Delta t$
$\Delta\theta = \omega_i\Delta t + \frac{1}{2}\alpha(\Delta t)^2$	$\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$
$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$	$v_f^2 = v_i^2 + 2a\Delta x$
$\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\Delta t$	$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$

The quantity ω in these equations represents the *instantaneous angular velocity* of the rotating object rather than the average angular velocity.

Table 1
Angular Substitutes for Linear Quantities

Angular	Linear
θ	x
ω	v
α	a

extension

Practice Problems

Visit go.hrw.com to find sample and practice problems for angular displacement, angular velocity, angular acceleration, and angular kinematics.

Keyword HF6APJX