Chapter 8: Rotational Kinematics

Essential Concepts and Summary

Rotational Motion and Angular Displacement

- When a rigid body rotates about fixed axis, angular displacement is the angle swept out by an imaginary "radius" of the body
- Counterclockwise is positive, clockwise is negative
- Radian is SI unit, defined as arc length divided by radius

$$\theta_{radians} = \frac{s}{r}$$

Angular Velocity and Angular Acceleration

- Average angular velocity is angular displacement divided by time

$$\bar{\omega} = \frac{\Delta\theta}{\Delta t}$$

- Average angular acceleration is the change in angular velocity divided by time

$$\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$$

Equations of Rotational Kinematics

$$\omega = \omega_0 + \alpha t$$

$$\theta = \frac{1}{2}\left(\omega + \omega_0\right)t$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega^2 = \omega_0{}^2 + 2\alpha\theta$$

Angular Variables and Tangential Variables

- Any point on the rigidly rotating body moves on a circular arc of length s and radius r
- We can relate angular and tangential variables by these equations

$$s = r\theta$$

$$v_T = r\omega$$

$$a_T = r\alpha$$

Centripetal Acceleration and Tangential Acceleration

- Magnitude of centripetal acceleration of a point on an object rotating with uniform, or nonuniform, circular motion can be expressed in terms of radial distance and angular speed

$$a_c = r\omega^2$$

Rolling Motion

- No slipping at the point where object touches the surface
- As a result, linear equals tangential velocity of the edge point
- Similarly, tangential acceleration and linear acceleration are equal

$$v = v_T = r\omega$$

$$a = a_T = r\alpha$$

Vector Nature of Angular Variables

- Right Hand Rule: Grasp axis of rotation with right hand, so fingers circle in the same sense as the rotation. Your thumb points in the direction of the angular velocity, or angular acceleration, variable.