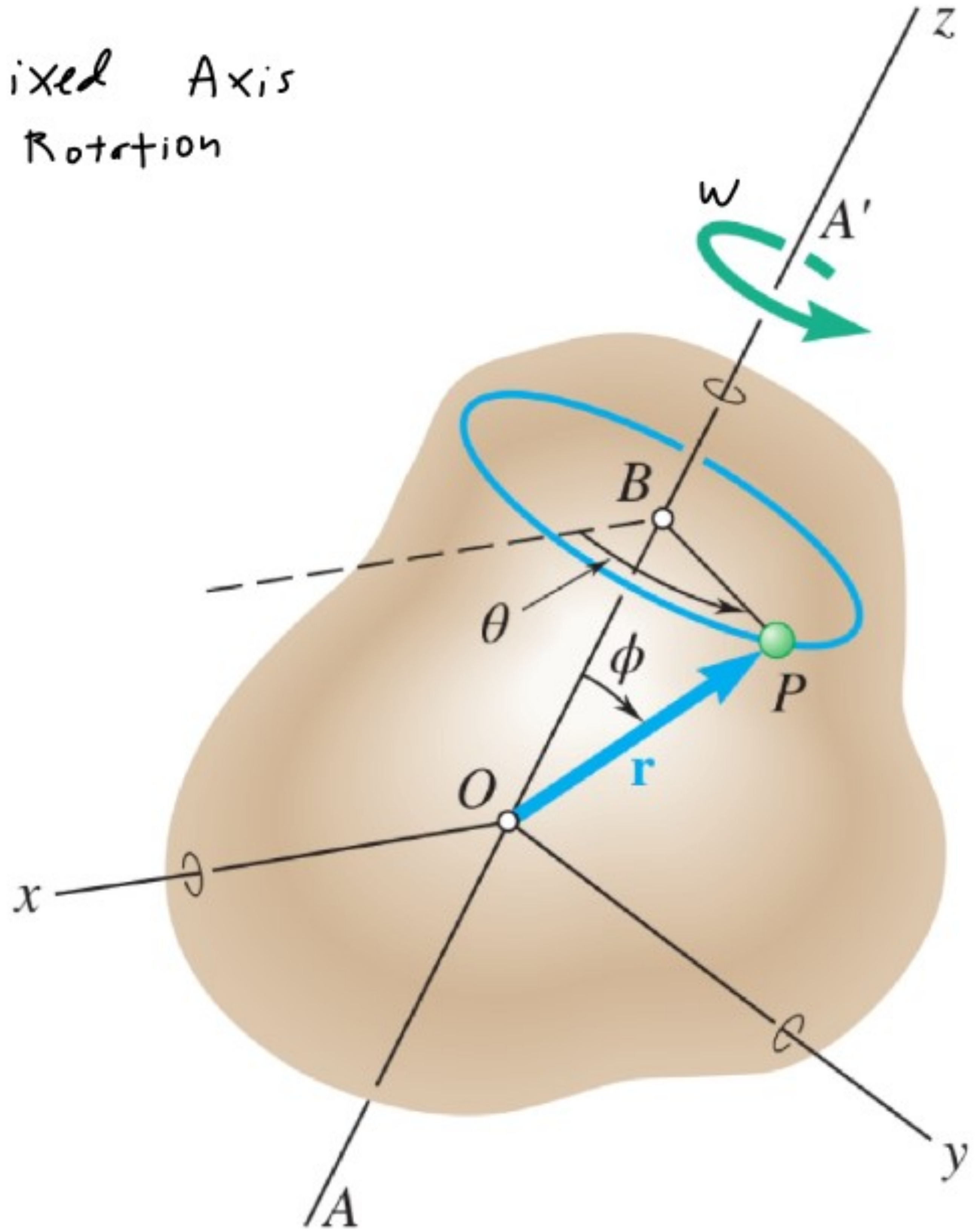
Fixed Axis Rotation



$$\vec{V} = \vec{w} \times \vec{r}$$

$$\vec{a} = \vec{\alpha} \times \vec{r} + \vec{w} \times (\vec{w} \times \vec{r})$$

$$w = \frac{d\theta}{dt}$$

$$\alpha = \frac{dw}{dt} = \frac{d^2\theta}{dt^2} = w\frac{dw}{d\theta}$$

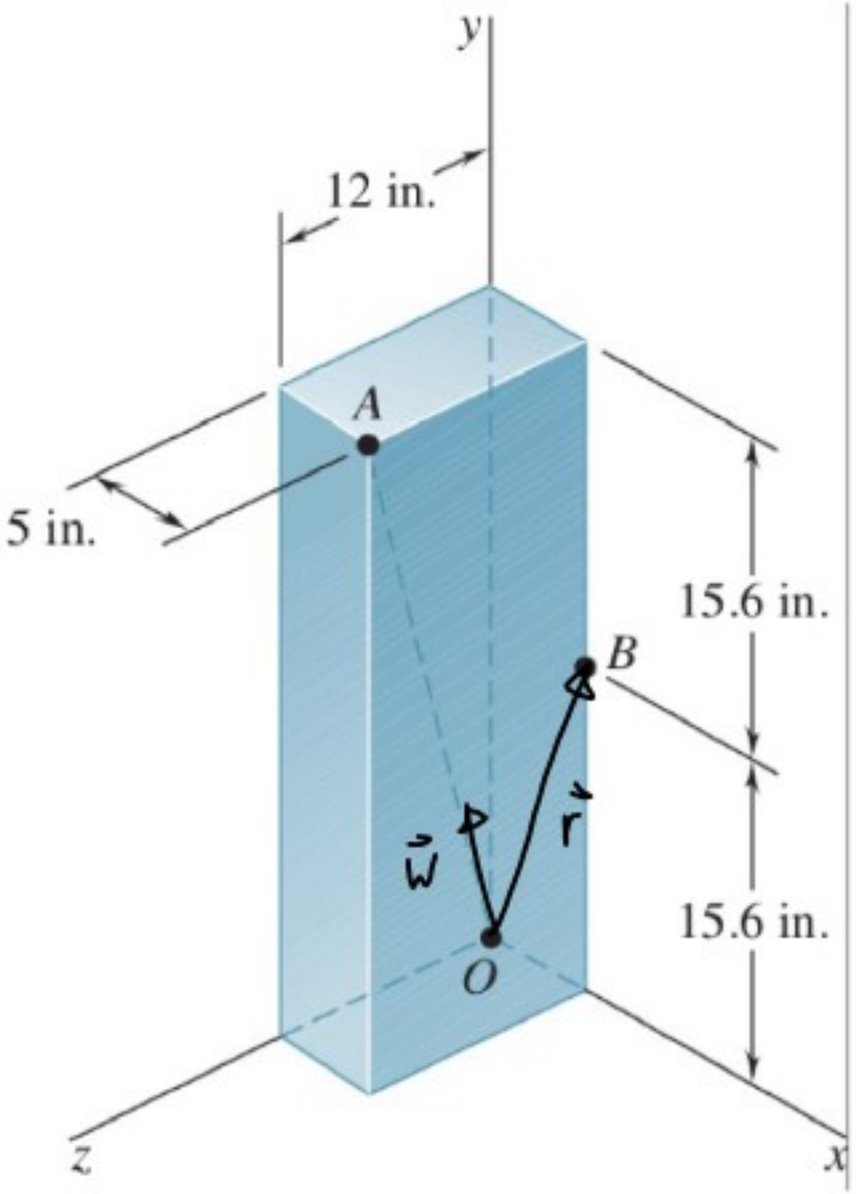
θ angle

w angular vel

α angular accel

$\omega = \omega_0 + \alpha t$

The rectangular block shown rotates about the diagonal *OA* with a constant angular velocity of 6.76 rad/s. Knowing that the rotation is counterclockwise as viewed from *A*, determine the velocity and acceleration of point *B* at the instant shown.



$\vec{r} = 5i + 15.6j$ in

$\vec{OA} = 5i + 31.2j + 12k$ in

$OA = \sqrt{5^2 + 31.2^2 + 12^2} = 33.8$ in

$\lambda = \dfrac{5i + 31.2j + 12k}{33.8} = 0.15i + 0.92j + 0.36k$

$\omega = 6.76$ rad/s

$\vec{w} = \omega\lambda = 6.76(0.15i + 0.92j + 0.36k)$
$= 1i + 6.24j + 2.4k$ rad/s

$\vec{\alpha} = 0$

$\vec{V} = \vec{w} \times \vec{r}$

$$= \left| \begin{matrix} i & j & k \\ 1 & 6.24 & 2.4 \\ 5 & 15.6 & 0 \end{matrix} \right| \begin{matrix} i & j \\ 1 & 6.24 \\ 5 & 15.6 \end{matrix}$$

$= 2.4 \cdot 5j + 15.6k - 6.24 \cdot 5k - 2.4 \cdot 15.6i$

$\boxed{\vec{V} = -37.44i + 12j - 15.6k \text{ in/s}}$

$$\vec{a} = \cancelto{0}{\vec{\alpha}\times\vec{r}} + \vec{\omega}\times(\vec{\omega}\times\vec{r})$$

$$= \vec{\omega}\times\vec{v}$$

$$= \left|\begin{matrix} i & j & k \\ 1 & 6.24 & 2.4 \\ -37.44 & 12 & -15.6 \end{matrix}\right| \begin{matrix} i & j \\ 1 & 6.24 \\ -37.44 & 12 \end{matrix}$$

$$= -6.24\cdot 15.6\, i - 2.4\cdot 37.44\, j + 12k + 6.24\cdot 37.44\, k - 2.4\cdot 12\, i + 15.6\, j$$

$$\boxed{= -126 i - 74 j + 246 k \ \text{in}/\text{s}^2}$$

The sprocket wheel and chain shown are initially at rest. If the wheel has a uniform angular acceleration of 90 rad/s^2 counterclockwise, determine (*a*) the acceleration of point *A* of the chain, (*b*) the magnitude of the acceleration of point *B* of the wheel after 3 s.