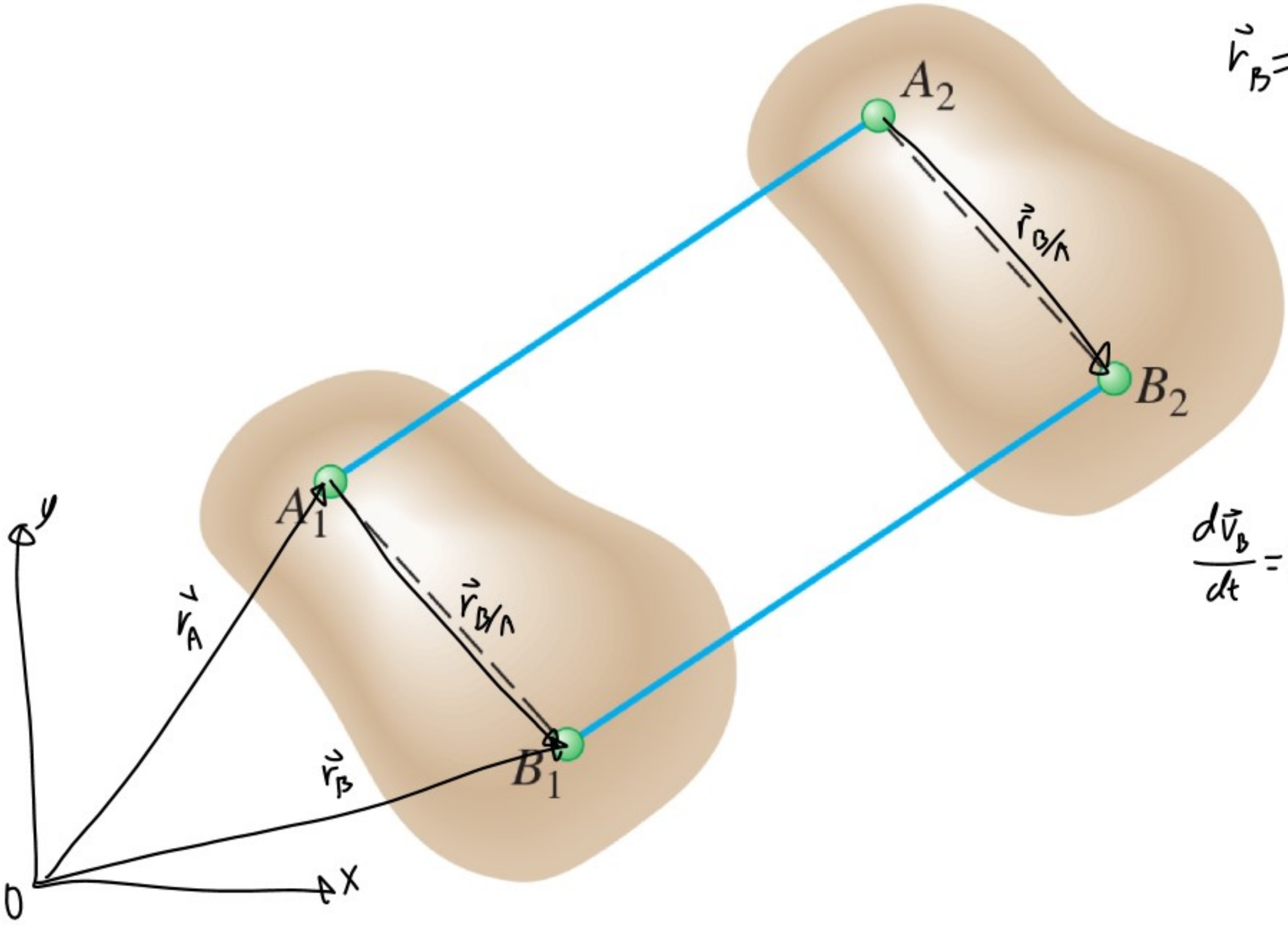
Translation



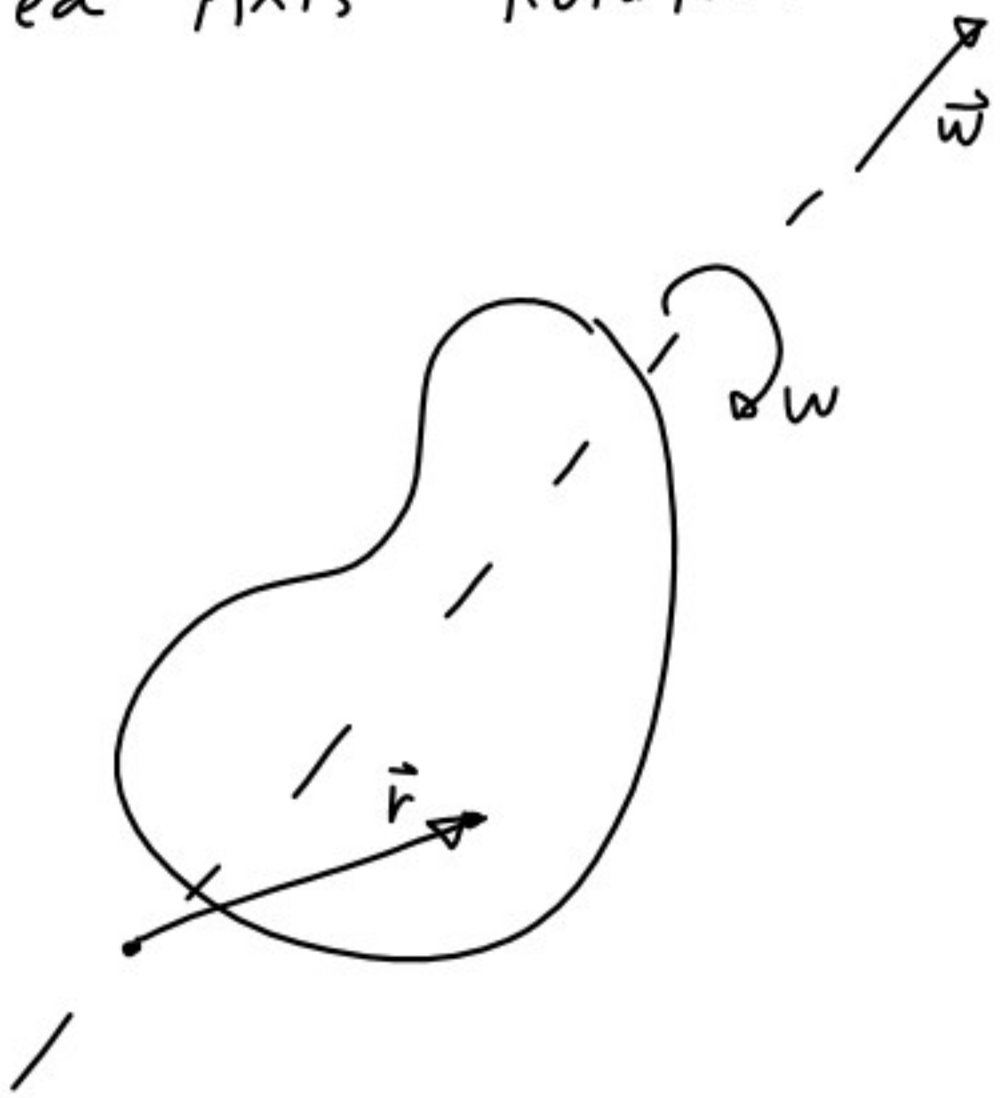
$$\vec{r}_B = \vec{r}_A + \vec{r}_{B/A}$$

$$\vec{r}_{B/A} = \text{constant}$$

$$\frac{d\vec{r}_B}{dt} = \vec{V}_B = \vec{V}_A$$

$$\frac{d\vec{V}_B}{dt} = \vec{a}_B = \vec{a}_A$$

Fixed Axis Rotation



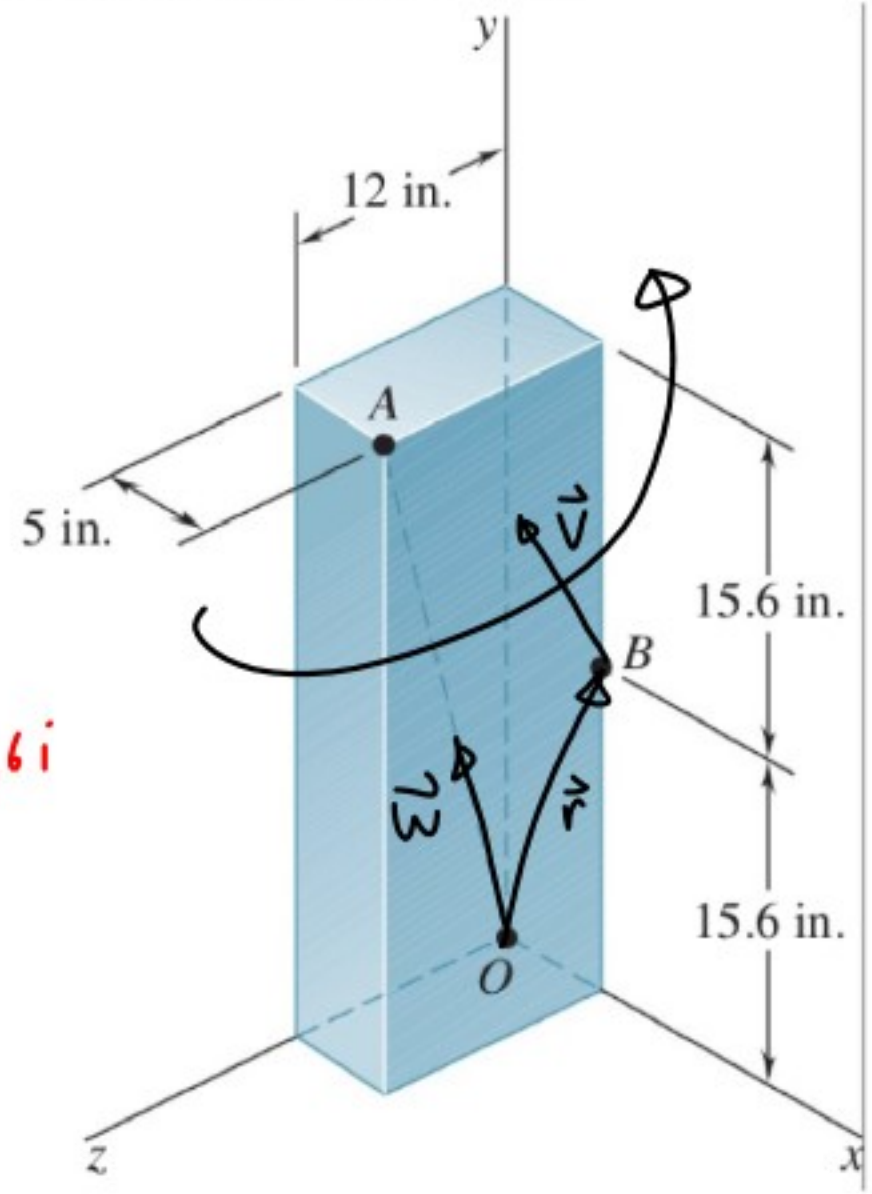
$$\vec{v} = \vec{w} \times \vec{r}$$

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

$$\vec{\alpha} = \frac{d\vec{w}}{dt} \qquad \vec{w} = \frac{d\vec{\theta}}{dt}$$

$$\vec{\alpha} = \vec{w}\,\frac{d\vec{w}}{d\vec{\theta}}$$

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.



$\vec{r} = 5i + 15.6j + 0k$ in

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

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

$\vec{\lambda} = \frac{5}{33.8} i + \frac{31.2}{33.8} j + \frac{12}{33.8} K$

$\vec{\omega} = 6.76 \vec{\lambda}$

$= 6.76\left(\frac{5}{33.8} i + \frac{31.2}{33.8} j + \frac{12}{33.8} K\right)$

$= 1i + 6.24j + 2.4K$ rad/s

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

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

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

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

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

$$\vec{a} = \vec{\omega} \times (\vec{\omega} \times \vec{r})$$

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

$$= -6.24(15.6)i + 2.4(-37.44)j + 12k + 6.24(37.44)k - 2.4(12)i + 15.6j$$

$$\boxed{\vec{a} = -126i - 74.3j + 246k \ \ \text{in}/\text{s}^2}$$

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.

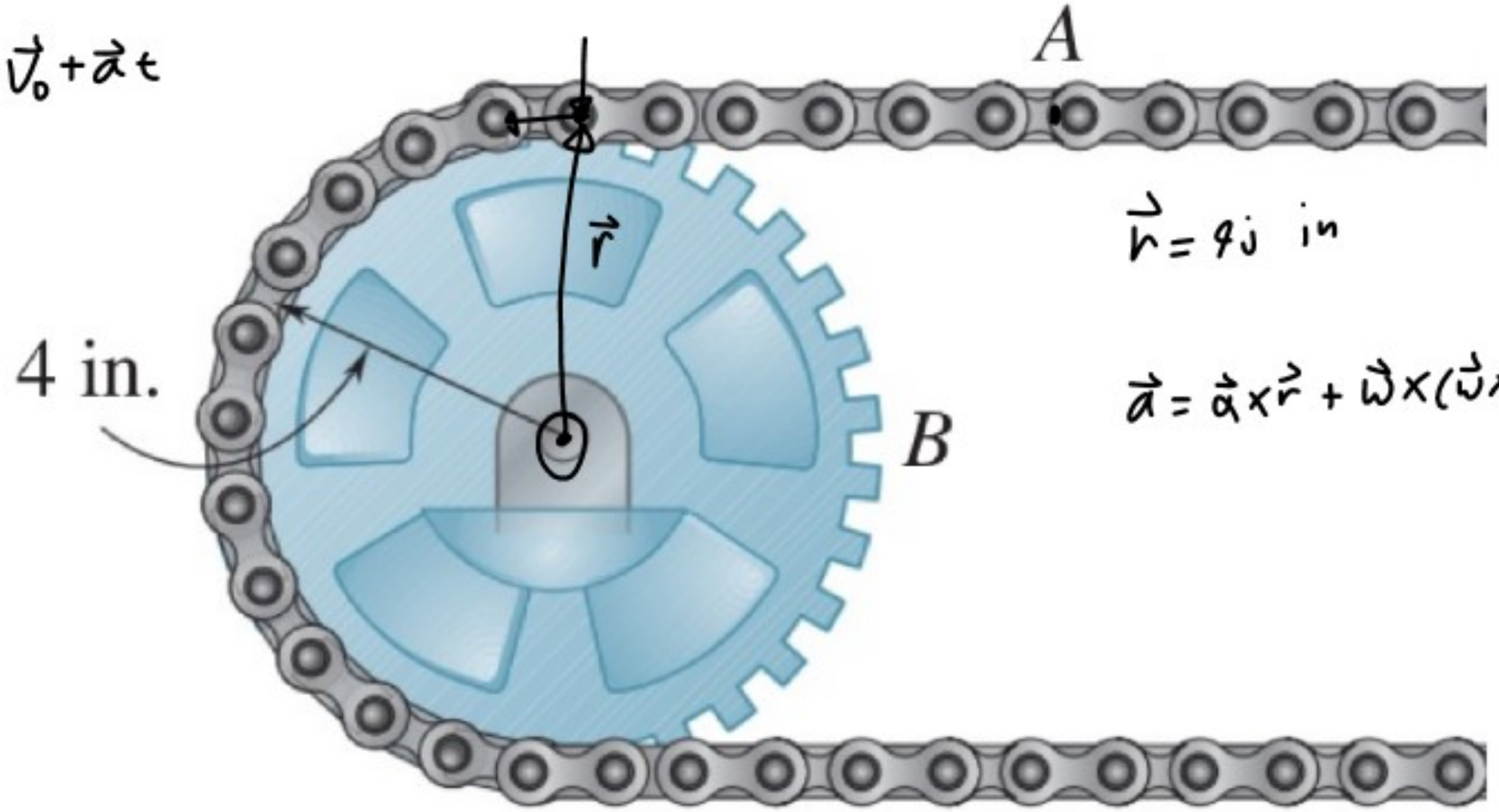
$\vec{\omega} = \cancel{\vec{\omega}_0} + \vec{\alpha} t$

$\vec{v} = \vec{v}_0 + \vec{a} t$

$\vec{\alpha} = 90 K \ \mathrm{rad/s^2}$

$\vec{\omega} = \vec{\alpha} t = 90 K \, 3$

$= 270 K \ \mathrm{rad/s}$



$\vec{r} = 4 j$ in

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

z x y

$$\vec{w} \times \vec{r} = \left|\begin{array}{ccc|cc} i & j & k & i & j \\ 0 & 0 & 270 & 0 & 0 \\ 0 & 4 & 0 & 0 & 4 \end{array}\right| = -4(270)\,i = 1080\,i \ \ {}^{in}/_{s}$$

$$\vec{w} \times (\vec{w} \times \vec{r}) = \left|\begin{array}{ccc|cc} i & j & k & i & j \\ 0 & 0 & 270 & 0 & 0 \\ 1080 & 0 & 0 & 1080 & 0 \end{array}\right| = 270(1080)\,j = 291600\,j \ \ {}^{in}/_{s^2}$$

$$\vec{\alpha} \times \vec{r} = \left|\begin{array}{ccc|cc} i & j & k & i & j \\ 0 & 0 & 90 & 0 & 0 \\ 0 & 4 & 0 & 0 & 4 \end{array}\right| = -4(90)\,i = -360\,i \ \ {}^{in}/_{s^2}$$

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

$$= -360\,i + 291600\,j \ \ {}^{in}/_{s^2}$$

$$\boxed{\vec{a}_A = -360\,i \ \ {}^{in}/_{s^2}}$$