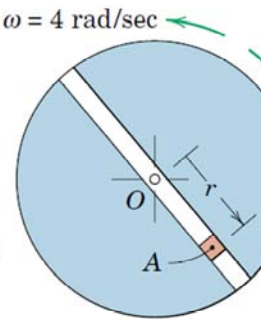
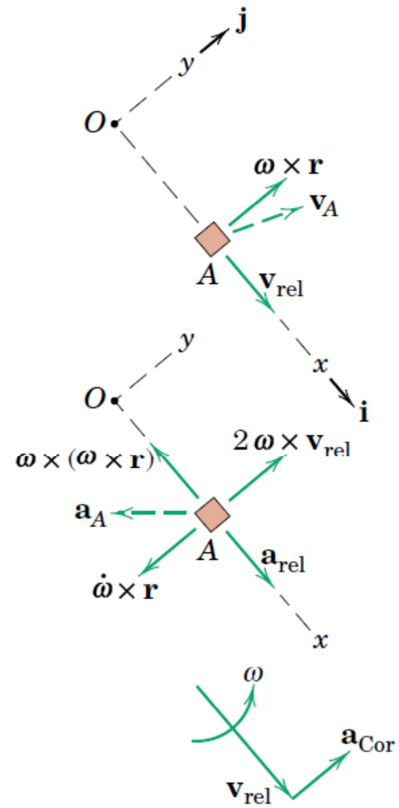
Relative Acceleration: Exercise

A ***disk*** with the radial slot is ***rotating*** ab
with ω = 4 rad/s and decreasing by 10 ra
The ***slider*** A motion is
$r = 6$ in, $\dot{r} = 5$ in/s, and
$\ddot{r} = 81$ in/s^2



Determine the ***absolute acceleration*** of A for this position.

$$\mathbf{a}_A = \mathbf{a}_B + \dot{\boldsymbol{\omega}} \times \mathbf{r} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) + 2\boldsymbol{\omega} \times \mathbf{v}_{rel} + \mathbf{a}_{rel}$$



Acceleration. Equation 5/14 written for zero acceleration of the origin of the rotating coordinate system is

$$\mathbf{a}_A = \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) + \dot{\boldsymbol{\omega}} \times \mathbf{r} + 2\boldsymbol{\omega} \times \mathbf{v}_{\text{rel}} + \mathbf{a}_{\text{rel}}$$

The terms become

$$\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) = 4\mathbf{k} \times (4\mathbf{k} \times 6\mathbf{i}) = 4\mathbf{k} \times 24\mathbf{j} = -96\mathbf{i} \text{ in./sec}^2$$

$$\dot{\boldsymbol{\omega}} \times \mathbf{r} = -10\mathbf{k} \times 6\mathbf{i} = -60\mathbf{j} \text{ in./sec}^2$$

$$2\boldsymbol{\omega} \times \mathbf{v}_{\text{rel}} = 2(4\mathbf{k}) \times 5\mathbf{i} = 40\mathbf{j} \text{ in./sec}^2$$

$$\mathbf{a}_{\text{rel}} = 81\mathbf{i} \text{ in./sec}^2$$

The total acceleration is, therefore,

$$\mathbf{a}_A = (81 - 96)\mathbf{i} + (40 - 60)\mathbf{j} = -15\mathbf{i} - 20\mathbf{j} \text{ in./sec}^2 \qquad \textit{Ans.}$$

in the direction indicated and has the magnitude

$$a_A = \sqrt{(15)^2 + (20)^2} = 25 \text{ in./sec}^2 \qquad \textit{Ans.}$$

Vector notation is certainly not essential to the solution of this problem. The student should be able to work out the steps with scalar notation just as easily. The correct direction of the Coriolis-acceleration term can always be found by the direction in which the head of the $\mathbf{v}_{\text{rel}}$ vector would move if rotated about its tail in the sense of $\boldsymbol{\omega}$ as shown.