20-R-KM-DK-29

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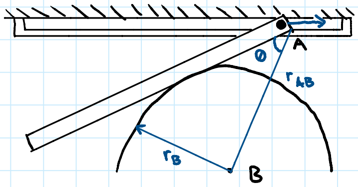
20-R-KM-DK-29 Advanced Time Derivative

Inspiration: 16-39 Hibbeler + Mech Notes



The end A of a bar is constrained by a horizontal slot. At one instant, the bar is moving with a velocity ***v* = 0.185 m/s** and acceleration ***a* = 0.1 m/s^2** to the right. If semicircle B has a radius ***r_B* = 0.5 m**, determine the angular velocity and angular acceleration of the bar at this instant. The distance from end A to the center of the semicircle is ***r_AB* = 0.8 m**.

Let $s = r_{AB}$, $r = r_B$ $\quad r = s\sin\theta \quad \sin\theta = \frac{r}{s} \quad \cos\theta\cdot\dot{\theta} = \frac{-r}{s^2}\cdot\dot{s}$ $\quad V_A$ is the horizontal component of $\dot{s}$

$$\cos\theta = \frac{\sqrt{s^2-r^2}}{s} \Rightarrow \frac{\sqrt{s^2-r^2}}{s}\dot{\theta} = -\frac{r}{s^2}\cdot\dot{s} \qquad \dot{\theta} = \frac{-r\dot{s}}{s\sqrt{s^2-r^2}} \qquad \dot{s}\cos\theta = V_A \qquad \dot{s} = \frac{V_A}{\cos\theta}$$

$$\dot{\theta} = \frac{-0.5\left(\frac{0.185}{\frac{\sqrt{0.8^2-0.5^2}}{0.8}}\right)}{0.8\sqrt{0.8^2-0.5^2}} = -0.237179 \text{ rad/s}$$

$$\boxed{\vec{\omega}_{Bar} = -0.237179\ \hat{k} \text{ rad/s}}$$

$$r = s\sin\theta \qquad \frac{dr}{dt} = \frac{d}{dt}s\sin\theta \Rightarrow 0 = \dot{s}\sin\theta + s\cos\theta\cdot\dot{\theta}$$

a_A is the horizontal component of $\ddot{s}$ $\quad \ddot{s}\cos\theta = a_A \quad \ddot{s} = \frac{a_A}{\cos\theta}$

$$\frac{d}{dt}(0) = \frac{d}{dt}(\dot{s}\sin\theta + s\cos\theta\cdot\dot{\theta}) \Rightarrow 0 = \ddot{s}\sin\theta + \dot{s}\cos\theta\cdot\dot{\theta} + \dot{s}\cos\theta\cdot\dot{\theta} - s\sin\theta\dot{\theta}^2 + s\cos\theta\cdot\ddot{\theta}$$

$$0 = \frac{0.1}{\frac{\sqrt{0.8^2-0.5^2}}{0.8}}\left(\frac{0.5}{0.8}\right) + \frac{(0.185)}{\frac{\sqrt{0.8^2-0.5^2}}{0.8}}\left(\frac{\sqrt{0.8^2-0.5^2}}{0.8}\right)(-0.237179)(2) - (0.8)\left(\frac{0.5}{0.8}\right)(-0.237179)^2 + 0.8\left(\frac{\sqrt{0.8^2-0.5^2}}{0.8}\right)\ddot{\theta}$$

$$\ddot{\theta} = 0.05735645$$

$$\boxed{\vec{\alpha}_{Bar} = 0.05735645\ \hat{k} \text{ rad/s}^2}$$