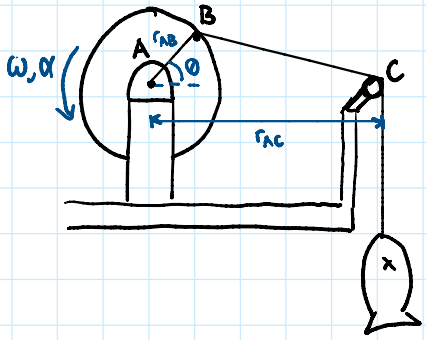
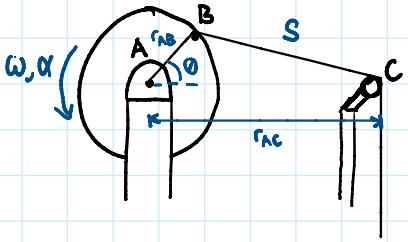
20-R-KM-DK-28

July 31, 2020 11:28 AM

20-R-KM-DK-28 Intermediate Time Derivative Inspiration: 16-56 Hibbeler

A student has set up a mechanism to catch fish. At a certain instant, the reel is rotating with an angular velocity of ***omega = 3 rad/s*** and has an angular acceleration of ***alpha = 0.15 rad/s^2***. Determine the velocity and acceleration of the fish at this instant. The disk has radius ***r_AB = 1.5 m***, and AB is currently at an angle of ***30 degrees*** with the horizontal. The distance from A to C is ***r_AC = 2.5 m***.





Using cosine law

$$s^2 = r_{AB}^2 + r_{AC}^2 - 2(r_{AB})(r_{AC})\cos\theta$$

$$s = \sqrt{r_{AB}^2 + r_{AC}^2 - 2(r_{AB})(r_{AC})\cos\theta}$$
$$= \sqrt{1.5^2 + 2.5^2 - 2(1.5)(2.5)\cos\theta}$$
$$= \sqrt{2.25 + 6.25 - 7.5\cos\theta}$$

$$\dot{s} = \tfrac{1}{2}(8.5 - 7.5\cos\theta)^{-\frac{1}{2}} \cdot (7.5\sin\theta)\cdot\dot{\theta} \qquad \dot{\theta} = \omega$$
$$= \tfrac{1}{2}(8.5 - 7.5\cos 30)^{-\frac{1}{2}} \cdot (7.5\sin 30)\cdot 3$$
$$= 3.9727\ldots$$

The fish is attached to the wire ∴ will have the same magnitude for its velocity as the wire. This also applies for the acceleration

$v_{fish} = 3.9727$ m/s

$$\ddot{s} = \frac{3.75(\dot{\theta}^2\cos\theta + \ddot{\theta}\sin\theta)}{(8.5 - 7.5\cos\theta)^{1/2}} - \frac{\frac{225}{16}\dot{\theta}^2\sin^2\theta}{(8.5 - 7.5\cos\theta)^{3/2}} = 16.8514 \text{ m/s}^2$$