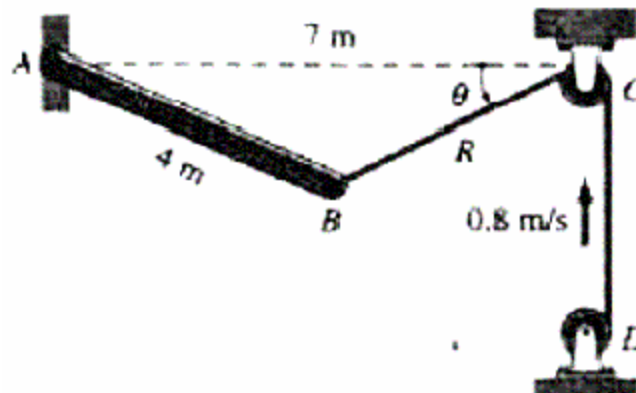


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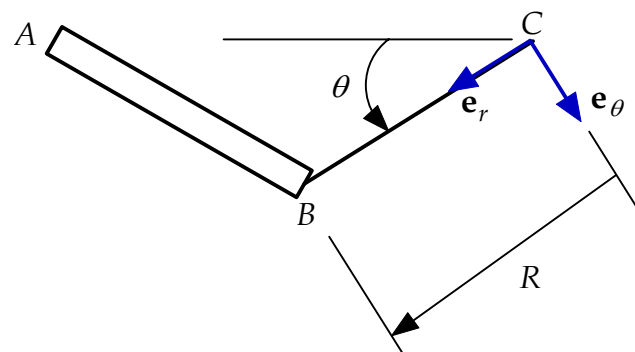
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Example 6.3

The winch D unwinds the cable BCD at the constant rate of 0.8 m/s . Determine the speed of end B of the bar AB when $R = 4 \text{ m}$.



Solution:



The velocity of B can be expressed in terms of polar coordinates using C as the fixed origin:

$$\mathbf{v}_B = \dot{R}\mathbf{e}_r + R\dot{\theta}\mathbf{e}_\theta \quad (\text{i})$$

Since the winch is unwinding cable BCD , R increases at the rate of 0.8 m/s. Thus:

$$\dot{R} = 0.8 \text{ m/s}$$

The rate at which θ is changing can be determined from the triangle ABC . Using the cosine rule we have:

$$R^2 + 7^2 - 2(7)R \cos \theta = 4^2$$

which results in an algebraic relationship between R and θ :

$$R^2 - 14R \cos \theta = -33 \quad (\text{ii})$$

For the given value of $R = 4 \text{ m}$, this expression results in $\theta = \arccos\left(\frac{49}{56}\right) = 28.96^\circ$. Differentiating (ii) with respect to time we obtain:

$$2\dot{R}R - 14(\dot{R} \cos \theta - R\dot{\theta} \sin \theta) = 0$$

Substituting the known values of R , \dot{R} , θ into this equation we can solve for $\dot{\theta}$:

$$\dot{\theta} = \frac{14\dot{R} \cos \theta - 2\dot{R}R}{14R \sin \theta} = 0.125 \text{ rad/s}$$

Substituting the computed values in (i) we obtain for the velocity of B :

$$\mathbf{v}_B = 0.8\mathbf{e}_r + 0.5\mathbf{e}_\theta \text{ m/s}$$

The speed of B at the given instant is the magnitude of this velocity:

$$v_B = \sqrt{0.8^2 + 0.5^2} = 0.94 \text{ m/s}$$