

Sample Problem 6/2

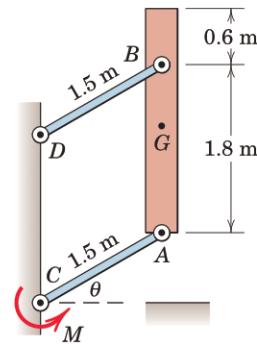
The vertical bar AB has a mass of 150 kg with center of mass G midway between the ends. The bar is elevated from rest at $\theta = 0$ by means of the parallel links of negligible mass, with a constant couple $M = 5 \text{ kN}\cdot\text{m}$ applied to the lower link at C . Determine the angular acceleration α of the links as a function of θ and find the force B in the link DB at the instant when $\theta = 30^\circ$.

- Solution.** The motion of the bar is seen to be curvilinear translation since the bar itself does not rotate during the motion. With the circular motion of the mass center G , we choose n - and t -coordinates as the most convenient description.
- ① With negligible mass of the links, the tangential component A_t of the force at A is obtained from the free-body diagram of AC , where $\sum M_C \approx 0$ and $A_t = M/\bar{AC} = 5/1.5 = 3.33 \text{ kN}$. The force at B is along the link. All applied forces are shown on the free-body diagram of the bar, and the kinetic diagram is also indicated, where the $m\ddot{\mathbf{a}}$ resultant is shown in terms of its two components.
 - ② The sequence of solution is established by noting that A_n and B depend on the n -summation of forces and, hence, on $m\bar{r}\omega^2$ at $\theta = 30^\circ$. The value of ω depends on the variation of $\alpha = \dot{\theta}$ with θ . This dependency is established from a force summation in the t -direction for a general value of θ , where $\bar{a}_t = (\bar{a}_t)_A = \bar{AC}\alpha$. Thus, we begin with

$$[\Sigma F_t = m\bar{a}_t] \quad 3.33 - 0.15(9.81) \cos \theta = 0.15(1.5\alpha)$$

$$\alpha = 14.81 - 6.54 \cos \theta \text{ rad/s}^2$$

Ans.



Helpful Hints

- ① Generally speaking, the best choice of reference axes is to make them coincide with the directions in which the components of the mass-center acceleration are expressed. Examine the consequences of choosing horizontal and vertical axes.
- ② The force and moment equations for a body of negligible mass become the same as the equations of equilibrium. Link BD , therefore, acts as a two-force member in equilibrium.

