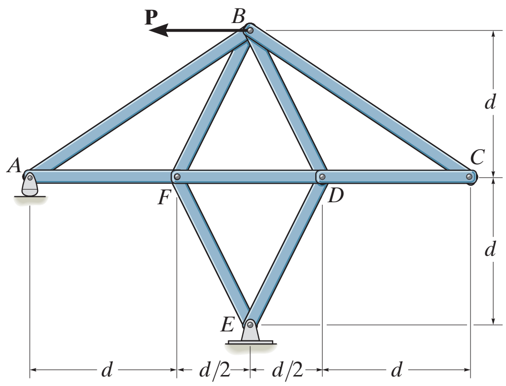
***6–16.**

If the maximum force that any member can support is 4 kN in tension and 3 kN in compression, determine the maximum force P that can be applied at joint B. Take $d = 1$ m.



SOLUTION

Support Reactions:

$$\circlearrowleft + \Sigma M_E = 0; \quad P(2d) - A_y\left(\frac{3}{2}d\right) = 0 \qquad A_y = \frac{4}{3}P$$

$$+\uparrow \Sigma F_y = 0; \quad \frac{4}{3}P - E_y = 0 \qquad E_y = \frac{4}{3}P$$

$$\xrightarrow{+} \Sigma F_x = 0; \quad E_x - P = 0 \qquad E_x = P$$

Method of Joints: By inspection of joint C, members CB and CD are zero force members. Hence

$$F_{CB} = F_{CD} = 0$$

Joint A:

$$+\uparrow \Sigma F_y = 0; \quad F_{AB}\left(\frac{1}{\sqrt{3.25}}\right) - \frac{4}{3}P = 0 \qquad F_{AB} = 2.404P \text{ (C)}$$

$$\xrightarrow{+} \Sigma F_x = 0; \quad F_{AF} - 2.404P\left(\frac{1.5}{\sqrt{3.25}}\right) = 0 \qquad F_{AF} = 2.00P \text{ (T)}$$

Joint B:

$$\xrightarrow{+} \Sigma F_x = 0; \quad 2.404P\left(\frac{1.5}{\sqrt{3.25}}\right) - P - F_{BF}\left(\frac{0.5}{\sqrt{1.25}}\right) - F_{BD}\left(\frac{0.5}{\sqrt{1.25}}\right) = 0$$

$$1.00P - 0.4472F_{BF} - 0.4472F_{BD} = 0 \qquad \textbf{(1)}$$

$$+\uparrow \Sigma F_y = 0; \quad 2.404P\left(\frac{1}{\sqrt{3.25}}\right) + F_{BD}\left(\frac{1}{\sqrt{1.25}}\right) - F_{BF}\left(\frac{1}{\sqrt{1.25}}\right) = 0$$

$$1.333P + 0.8944F_{BD} - 0.8944F_{BF} = 0 \qquad \textbf{(2)}$$

Solving Eqs. (1) and (2) yield,

$$F_{BF} = 1.863P \text{ (T)} \qquad F_{BD} = 0.3727P \text{ (C)}$$

Joint F:

$$+\uparrow \Sigma F_y = 0; \quad 1.863P\left(\frac{1}{\sqrt{1.25}}\right) - F_{FE}\left(\frac{1}{\sqrt{1.25}}\right) = 0$$

$$F_{FE} = 1.863P \text{ (T)}$$

$$\xrightarrow{+} \Sigma F_x = 0; \quad F_{FD} + 2\left[1.863P\left(\frac{0.5}{\sqrt{1.25}}\right)\right] - 2.00P = 0$$

$$F_{FD} = 0.3333P \text{ (T)}$$

Joint D:

$$+\uparrow \Sigma F_y = 0; \quad F_{DE}\left(\frac{1}{\sqrt{1.25}}\right) - 0.3727P\left(\frac{1}{\sqrt{1.25}}\right) = 0$$

$$F_{DE} = 0.3727P \text{ (C)}$$

$$\xrightarrow{+} \Sigma F_y = 0; \quad 2\left[0.3727P\left(\frac{0.5}{\sqrt{1.25}}\right)\right] - 0.3333P = 0 \ (\textit{Check!})$$

From the above analysis, the maximum compression and tension in the truss members are $2.404P$ and $2.00P$, respectively. For this case, compression controls which requires

$$2.404P = 3$$

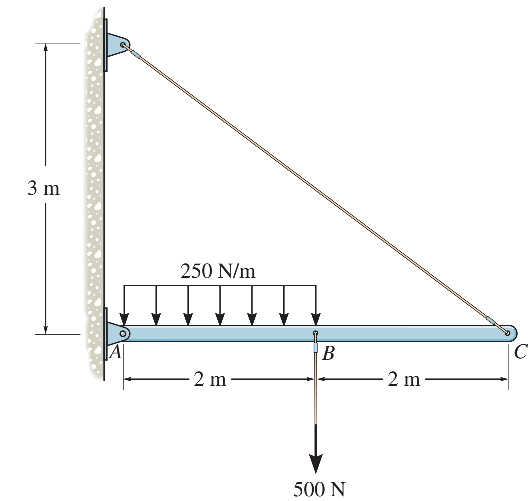
$$P = 1.25 \text{ kN}$$

Ans:

$P = 1.25$ kN

7–74.

Draw the shear and moment diagrams for the beam.

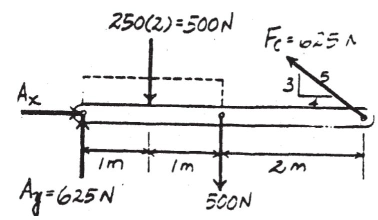


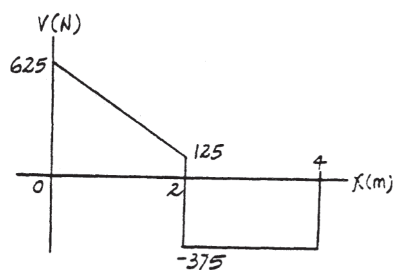
SOLUTION

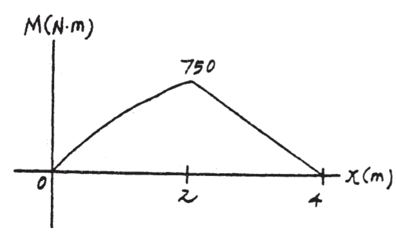
Support Reactions:

$\circlearrowleft + \Sigma M_A = 0; \qquad F_C\left(\frac{3}{5}\right)(4) - 500(2) - 500(1) = 0 \qquad F_C = 625\text{ N}$

$+\uparrow \Sigma F_y = 0; \qquad A_y + 625\left(\frac{3}{5}\right) - 500 - 500 = 0 \qquad A_y = 625\text{ N}$



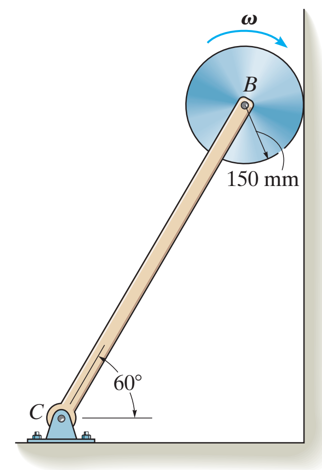




Ans:
$x = 2^+$
$V = -375\text{ N}$
$M = 750\text{ N}\cdot\text{m}$

17–77.

The disk has a mass of 20 kg and is originally spinning at the end of the strut with an angular velocity of $\omega = 60$ rad/s. If it is then placed against the wall, where the coefficient of kinetic friction is $\mu_k = 0.3$, determine the time required for the motion to stop. What is the force in strut BC during this time?



SOLUTION

$\overset{+}{\rightarrow} \Sigma F_x = m(a_G)_x; \qquad F_{CB} \sin 30° - N_A = 0$

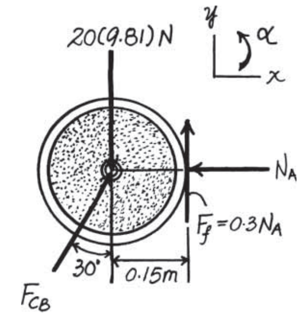
$+\uparrow \Sigma F_y = m(a_G)_y; \qquad F_{CB} \cos 30° - 20(9.81) + 0.3N_A = 0$

$\circlearrowleft + \Sigma M_B = I_B\,\alpha; \qquad 0.3N_A(0.15) = \left[\frac{1}{2}(20)(0.15)^2\right]\alpha$

$$N_A = 96.6 \text{ N}$$

$$F_{CB} = 193 \text{ N} \qquad \textbf{Ans.}$$

$$\alpha = 19.3 \text{ rad/s}^2$$



$\circlearrowright +$ $$\omega = \omega_0 + \alpha_c\, t$$

$$0 = 60 + (-19.3)\, t$$

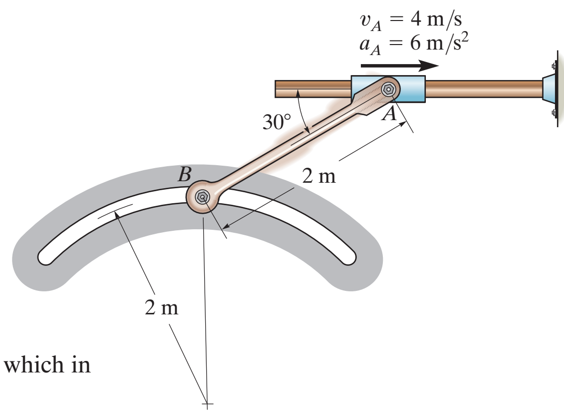
$$t = 3.11 \text{ s} \qquad \textbf{Ans.}$$

Ans:

$F_{CB} = 193$ N
$t = 3.11$ s

***16–116.**

At a given instant the slider block A is moving to the right with the motion shown. Determine the angular acceleration of link AB and the acceleration of point B at this instant.



SOLUTION

General Plane Motion. The IC of the link can be located using $\mathbf{v}_A$ and $\mathbf{v}_B$, which in this case is at infinity as shown in Fig. *a*. Thus

$$r_{A/IC} = r_{B/IC} = \infty$$

Then the kinematics gives

$$v_A = \omega\, r_{A/IC}; \quad 4 = \omega(\infty) \quad \omega = 0$$

$$v_B = v_A = 4 \text{ m/s}$$

Since B moves along a circular path, its acceleration will have tangential and normal components. Hence $(a_B)_n = \dfrac{v_B^2}{r_B} = \dfrac{4^2}{2} = 8 \text{ m/s}^2$

Applying the relative acceleration equation by referring to Fig. *b*,

$$\mathbf{a}_B = \mathbf{a}_A + \alpha \times \mathbf{r}_{B/A} - \omega^2\, \mathbf{r}_{B/A}$$

$$(a_B)_t\mathbf{i} - 8\mathbf{j} = 6\mathbf{i} + (\alpha\mathbf{k}) \times (-2\cos 30^\circ\mathbf{i} - 2\sin 30^\circ\mathbf{j}) - 0$$

$$(a_B)_t\mathbf{i} - 8\mathbf{j} = (\alpha + 6)\mathbf{i} - \sqrt{3}\alpha\mathbf{j}$$

Equating **i** and **j** componenets,

$$-8 = -\sqrt{3}\alpha; \quad \alpha = \frac{8\sqrt{3}}{3} \text{ rad/s}^2 = 4.62 \text{ rad/s}^2 \circlearrowleft \qquad \textbf{Ans.}$$

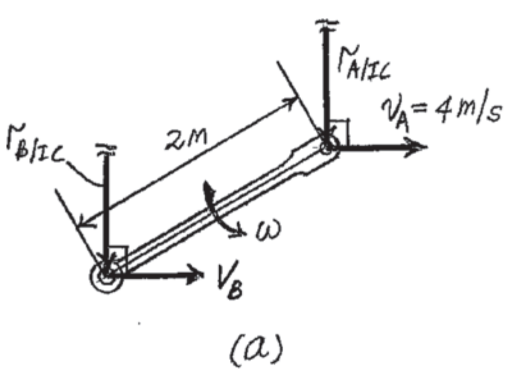
$$(a_B)_t = \alpha + 6; \quad (a_B)_t = \frac{8\sqrt{3}}{3} + 6 = 10.62 \text{ m/s}^2$$

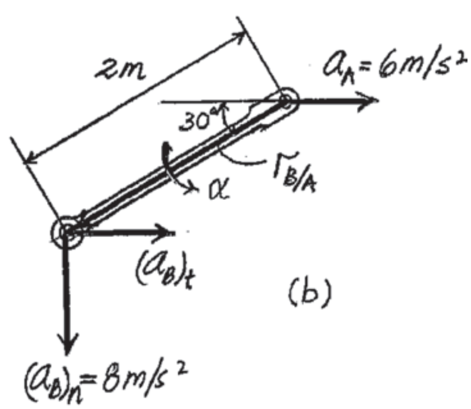
Thus, the magnitude of $\mathbf{a}_B$ is

$$a_B = \sqrt{(a_B)_t^2 + (a_B)_n^2} = \sqrt{10.62^2 + 8^2} = 13.30 \text{ m/s}^2 = 13.3 \text{ m/s}^2 \qquad \textbf{Ans.}$$

And its direction is defined by

$$\theta = \tan^{-1}\left[\frac{(a_B)_n}{(a_B)_t}\right] = \tan^{-1}\left(\frac{8}{10.62}\right) = 36.99^\circ = 37.0^\circ \measuredangle \qquad \textbf{Ans.}$$





Ans:
$\alpha_{AB} = 4.62$ rad/s^2 ↺
$a_B = 13.3$ m/s^2
$\theta = 37.0^\circ \measuredangle$