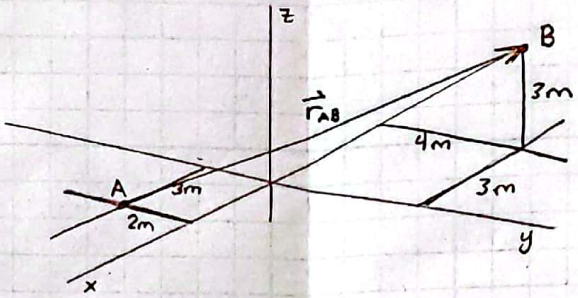
F2-19

Express $\vec{r}_{AB}$ in cartesian form; also give its magnitude and coordinate direction angles.



A (3, -2, 0) ✓

B (-3, 4, 3) ✓

SOLUTION

$$\vec{r}_{AB} = (-3-3)\hat{i} + (4--2)\hat{j} + (3-0)\hat{k} = -6\hat{i} + 6\hat{j} + 3\hat{k}$$

$$\boxed{\vec{r}_{AB} = (-6\hat{i} + 6\hat{j} + 3\hat{k})\,m} \quad ✓$$

$$r_{AB} = \sqrt{(-6)^2 + 6^2 + 3^2} = \sqrt{81} = 9$$

$$\boxed{r_{AB} = 9\ m} \quad ✓$$

$$\cos\alpha = \frac{-6}{9} = -\frac{2}{3}$$

$$\boxed{\alpha = 132^\circ} \quad ✓$$

$$\cos\beta = \frac{6}{9} = \frac{2}{3}$$

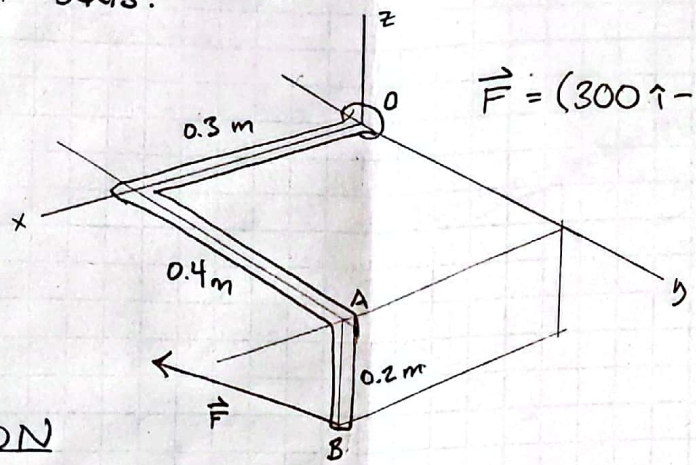
$$\boxed{\beta = 48^\circ} \quad ✓$$

$$\cos\gamma = \frac{3}{9} = \frac{1}{3}$$

$$\boxed{\gamma = 71^\circ} \quad ✓$$

F4-14

Determine the magnitude of the force F about the OA axis.



$\vec{F} = (300\hat{i} - 200\hat{j} + 150\hat{k})$ N

SOLUTION

$\overrightarrow{OA} = (0.3\hat{i} + 0.4\hat{j})$ m

$\hat{u}_{OA} = \frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$

$\vec{r} = (-0.2\,\hat{k})$ m

$$M_{OA} = \hat{u} \cdot (\vec{r} \times \vec{F}) = \begin{vmatrix} 3/5 & 4/5 & 0 \\ 0 & 0 & -0.2 \\ 300 & -200 & 150 \end{vmatrix}$$

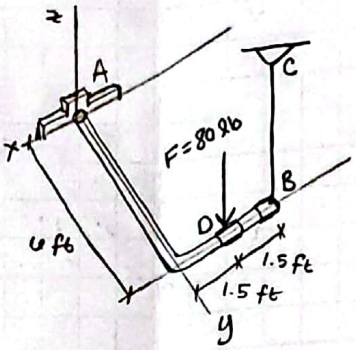
$= \frac{3}{5}(-40) - \frac{4}{5}(60) = -24 - 48 = \boxed{-72 \text{ N·m}}$ ✓

forgot to transfer negative sign

7/5

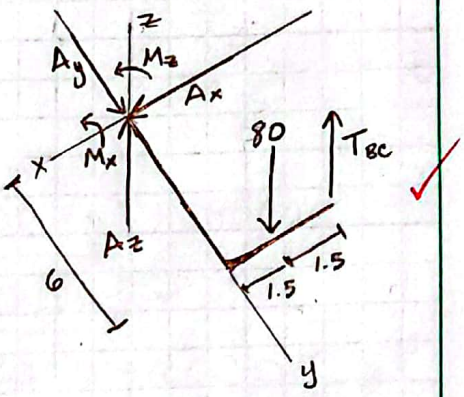
E5-12

Determine the components of reaction that the thrust bearing A and cable BC exert on the bar.



SOLUTION

FBD:



$\circlearrowleft_y \Sigma M = 0 = -(80)(1.5) + T_{BC}(3)$

$\boxed{T_{BC} = 40 \text{ lb}}$ ✓

$\Sigma F_z = 0 = A_z - 80 + 40$

$\boxed{A_z = 40 \text{ lb}}$ ✓

$\Sigma F_x = 0 = A_x$

$\boxed{A_x = 0}$ ✓

$\Sigma F_y = 0 = A_y$

$\boxed{A_y = 0}$ ✓

$\circlearrowleft_x \Sigma M = 0 = M_x - 80(6) + 40(6)$

$\boxed{M_x = 240 \text{ lb·ft}}$ ✓

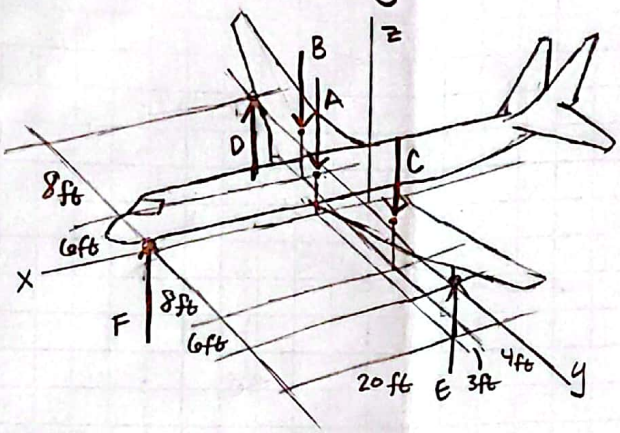
$\circlearrowleft_z \Sigma M = 0 = M_z$

$\boxed{M_z = 0}$ ✓

5-63

Determine the normal reactions of wheels D, E, and F on the ground.

FBD:



A = 45000 lb

B = 8000 lb

C = 6000 lb

SOLUTION

$\circlearrowleft \Sigma M_y = 0 = -F(27) + (8000)(4) + (6000)(4) + (45000)(7)$

$F = 13740 \text{ lb}$ ✓

$\Sigma F_z = 0 = 13740 + D + E - 45000 - 8000 - 6000$

$D + E = 45260$

$\circlearrowleft \Sigma M_x = 0 = E(14) - (6000)(8) + (8000)(6) - D(14)$

$E = D$

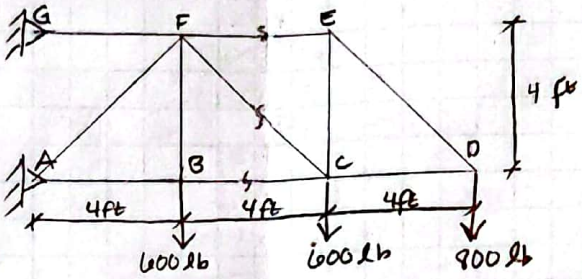
$2D = 45260$

$D = 22630 \text{ lb}$ ✓

$E = 22630 \text{ lb}$ ✓

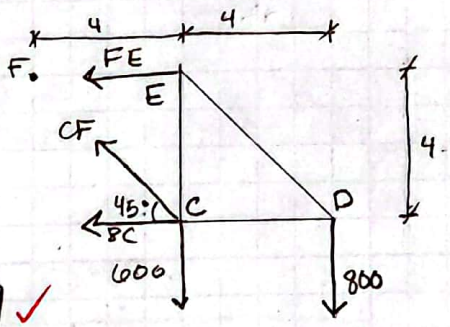
F6-7

Determine the force in members BC, CF, and FE.



SOLUTION

FBD of section:



$\circlearrowleft_C \Sigma M = -(800)(4) + FE(4) = 0$

$\boxed{FE = 800 \text{ lb (T)}}$ ✓

$\circlearrowleft_F \Sigma M = -(800)(8) - (600)(4) - BC(4) = 0$

$\boxed{BC = 2200 \text{ lb (C)}}$ ✓

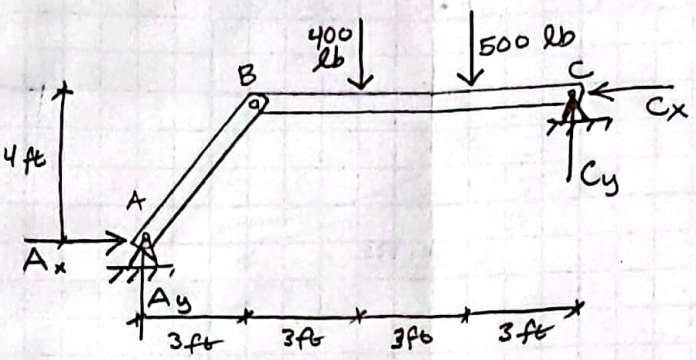
$\Sigma F_y = -800 - 600 + CF \sin 45° = 0$

$\boxed{CF = 1980 \text{ lb (T)}}$ ✓

NOTE: Use ΣF_x as a check.

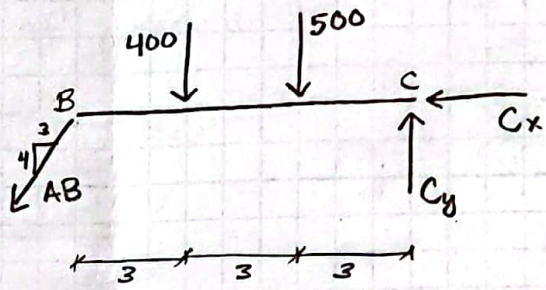
F6-14

Determine the reaction at pin C.



SOLUTION

FBD of BC:



$\circlearrowleft_B \Sigma M = C_y(9) - (400)(3) - (500)(6) = 0$

$C_y = 467$ lb

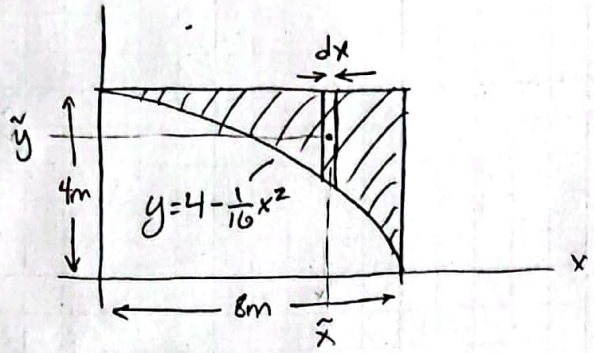
$\Sigma F_y = 467 - 400 - 500 - \frac{4}{5} AB = 0$

$AB = -541$ lb

$= 541$ lb (C)

$\Sigma F_x = \frac{3}{5}(541) - C_x = 0$

$C_x = 325$ lb



$$dA = \left(4 - \left(4 - \frac{1}{16}x^2\right)\right) dx = \frac{1}{16}x^2\,dx$$

$$\tilde{x} = x$$

$$\tilde{y} = \left(4 - \frac{1}{16}x^2\right) + \frac{4 - \left(4 - \frac{1}{16}x^2\right)}{2} = 4 - \frac{1}{16}x^2 + \frac{1}{32}x^2 = 4 + \frac{1}{32}x^2$$

$$\int dA = \int_0^8 \frac{1}{16}x^2\,dx = \frac{1}{16}\left(\frac{1}{3}\right)x^3\Big|_0^8 = \frac{32}{3}$$

$$\int \tilde{x}\,dA = \int_0^8 x\left(\frac{1}{16}x^2\right)dx = \frac{1}{16}\left(\frac{1}{4}\right)x^4\Big|_0^8 = 64$$

$$\int \tilde{y}\,dA = \int_0^8 \left(4 - \frac{1}{32}x^2\right)\frac{1}{16}x^2\,dx = \int_0^8 \left(\frac{1}{4}x^2 - \frac{1}{512}x^4\right)dx = \frac{1}{4}\left(\frac{1}{3}\right)x^3\Big|_0^8 - \frac{1}{512}\left(\frac{1}{5}\right)x^5\Big|_0^8$$

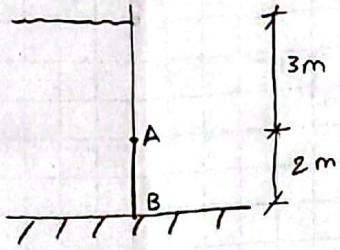
$$= \frac{128}{3} - \frac{64}{5} = \frac{448}{15}$$

$$\bar{x} = \frac{\int \tilde{x}\,dA}{\int dA} = \frac{3}{32}(64) = \boxed{6\text{ m}}$$

$$\bar{y} = \frac{\int \tilde{y}\,dA}{dA} = \frac{3}{32}\left(\frac{448}{15}\right) = \frac{42}{15} = \boxed{2.8\text{ m}}$$

F9-20

Determine the magnitude of the hydrostatic force acting on gate AB.



$\rho = 1\ Mg/m^3$

$L = 2\ m$

SOLUTION

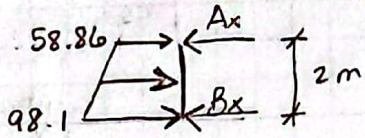
$w_A = (1000\ \frac{kg}{m^3})(9.81\ \frac{m}{s^2})(3m)(2m)$

$= 58860\ \frac{N}{m} = 58.86\ \frac{kN}{m}$

$w_B = (1\ \frac{Mg}{m^3})(9.81\ \frac{m}{s^2})(5m)(2m)$

$= 98.1\ \frac{kN}{m}$

FBD:



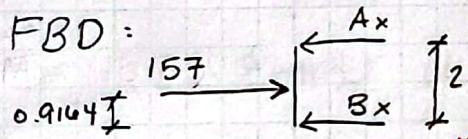
$R = (58.86)(2) + \frac{1}{2}(98.1-58.86)(2) = 156.96\ kN$

$= 157\ kN$

$(157)\,x = (117.72)(1) + (39.24)(\frac{2}{3})$

$x = 0.9164$

FBD:



$\circlearrowleft_A \Sigma M = (157)(2-0.9164) - B_x(2)$

$B_x = 85.1\ kN$

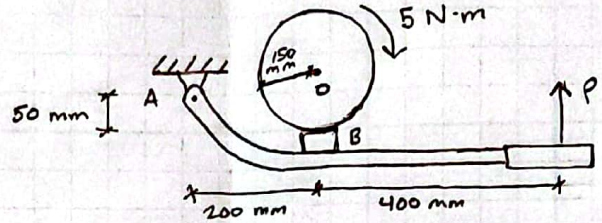
$\circlearrowleft_B \Sigma M = A_x(2) - (157)(0.9164)$

$A_x = 71.9\ kN$

8-7

Determine whether the brake can hold the wheel stationary.

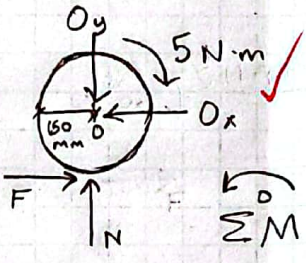
(a) P = 30 N
(b) P = 70 N



$\mu_s = 0.3$

SOLUTION

FBD of wheel:



$\Sigma F_x = \emptyset = F - O_x \quad O_x = F$

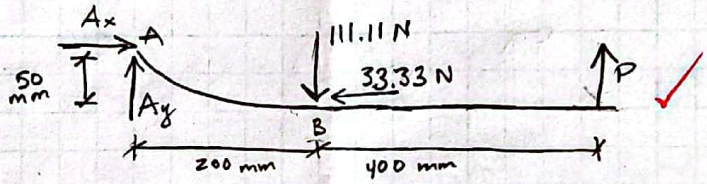
$\Sigma F_y = \emptyset = N - O_y \quad O_y = N$

$\curvearrowleft_O \Sigma M = 0 = F(0.15\ m) - 5\ N \cdot m$

$F = 33.33\ N$

$F = \mu_s N \quad N = \frac{F}{\mu_s} = \frac{33.33\ N}{0.3} = 111.11\ N$

FBD of lever:



$\curvearrowleft_A \Sigma M = 0 = P(0.6\ m) - (111.11\ N)(0.2\ m) - (33.33\ N)(0.05\ m)$

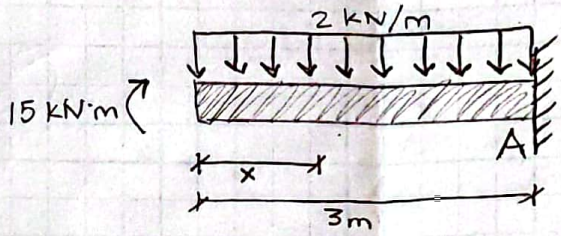
$P = 39.8\ N = 40\ N$ sufficient: $P \geq 40\ N$

(a) $P = 30\ N < 39.8\ N$ — No - insufficient force

(b) $P = 70\ N > 39.8\ N$ — Yes - sufficient force

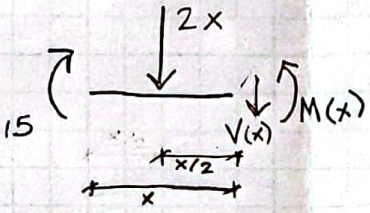
F7-8

Determine the shear and moment as a function of x; draw shear and moment diagrams.



SOLUTION

FBD of section:



$\Sigma F_y = 0 = -V(x) - 2x$

$V(x) = -2x$ kN ✓

$\Sigma M_{cut} = M(x) + (2x)\left(\frac{x}{2}\right) - 15$

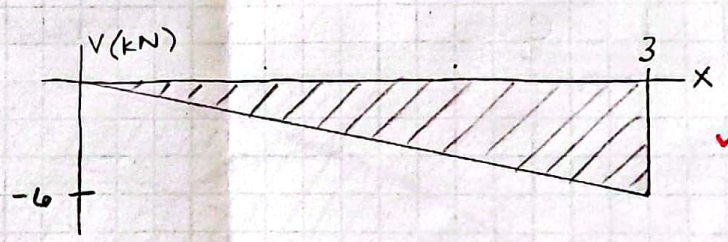
$= M(x) + x^2 - 15$

$M(x) = (15 - x^2)$ kN·m ✓

Shear

$V(x) = -2x$

$0 \le x \le 3$

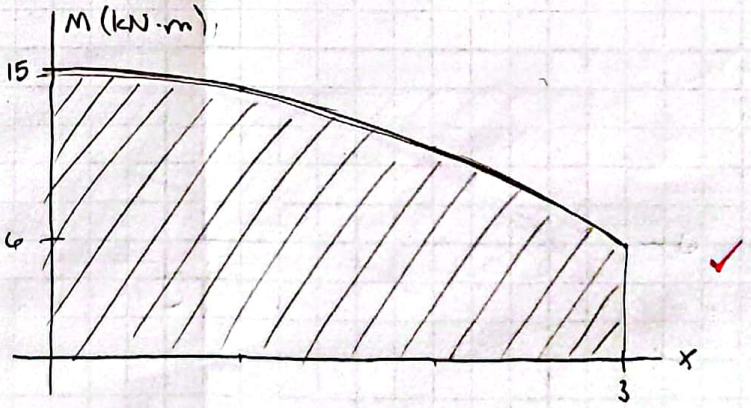


✓

Moment

$M(x) = 15 - x^2$

$0 \le x \le 3$



✓