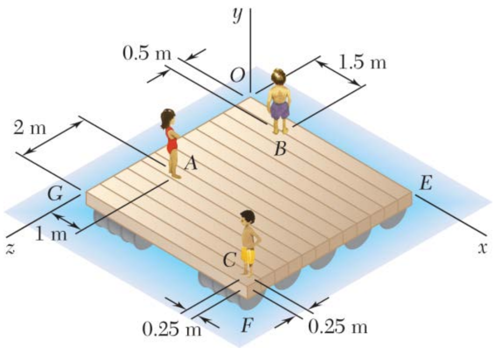
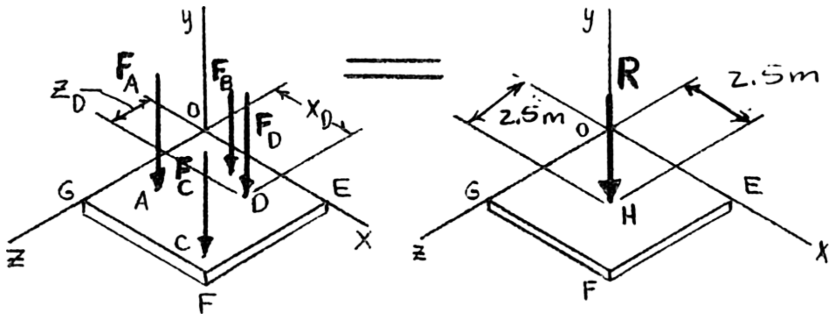


PROBLEM 3.128

Three children are standing on a 5×5-m raft. The weights of the children at Points *A*, *B*, and *C* are 375 N, 260 N, and 400 N, respectively. If a fourth child of weight 425 N climbs onto the raft, determine where she should stand if the other children remain in the positions shown and the line of action of the resultant of the four weights is to pass through the center of the raft.

SOLUTION



We have $\Sigma\mathbf{F}: \quad \mathbf{F}_A + \mathbf{F}_B + \mathbf{F}_C = \mathbf{R}$

$$-(375\text{ N})\mathbf{j} - (260\text{ N})\mathbf{j} - (400\text{ N})\mathbf{j} - (425\text{ N})\mathbf{j} = \mathbf{R}$$

$$\mathbf{R} = -(1460\text{ N})\mathbf{j}$$

We have $\Sigma M_x: \quad F_A(z_A) + F_B(z_B) + F_C(z_C) + F_D(z_D) = R(z_H)$

$$(375\text{ N})(3\text{ m}) + (260\text{ N})(0.5\text{ m}) + (400\text{ N})(4.75\text{ m})$$
$$+ (425\text{ N})(z_D) = (1460\text{ N})(2.5\text{ m})$$

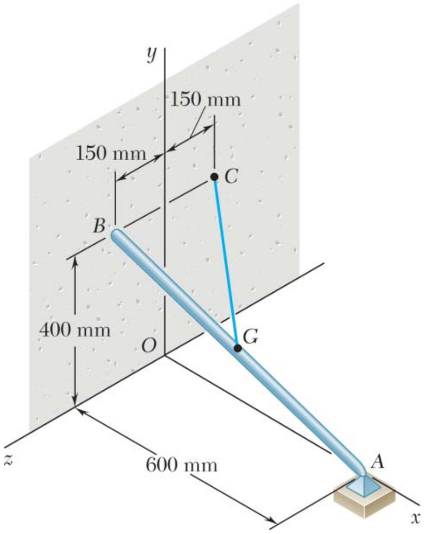
$z_D = 1.16471\text{ m}$ or $z_D = 1.165\text{ m}$ ◀

We have $\Sigma M_z: \quad F_A(x_A) + F_B(x_B) + F_C(x_C) + F_D(x_D) = R(x_H)$

$$(375\text{ N})(1\text{ m}) + (260\text{ N})(1.5\text{ m}) + (400\text{ N})(4.75\text{ m})$$
$$+ (425\text{ N})(x_D) = (1460\text{ N})(2.5\text{ m})$$

$x_D = 2.3235\text{ m}$ or $x_D = 2.32\text{ m}$ ◀

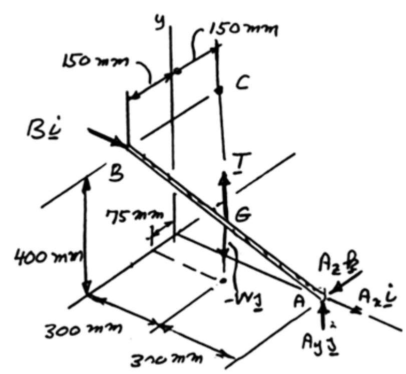
PROBLEM 4.132



The uniform 10-kg rod *AB* is supported by a ball-and-socket joint at *A* and by the cord *CG* that is attached to the midpoint *G* of the rod. Knowing that the rod leans against a frictionless vertical wall at *B*, determine (*a*) the tension in the cord, (*b*) the reactions at *A* and *B*.

SOLUTION

Free-Body Diagram:



Five unknowns and six equations of equilibrium, but equilibrium is maintained $(\Sigma M_{AB} = 0)$.

(*a*)

$$W = mg$$
$$= (10\text{ kg})\,9.81\,\text{m/s}^2$$
$$W = 98.1\text{ N}$$

$$\overrightarrow{GC} = -300\mathbf{i} + 200\mathbf{j} - 225\mathbf{k} \qquad GC = 425\text{ mm}$$

$$\mathbf{T} = T\frac{\overrightarrow{GC}}{GC} = \frac{T}{425}(-300\mathbf{i} + 200\mathbf{j} - 225\mathbf{k})$$

$$\mathbf{r}_{B/A} = -600\mathbf{i} + 400\mathbf{j} + 150\text{ mm}$$

$$\mathbf{r}_{G/A} = -300\mathbf{i} + 200\mathbf{j} + 75\text{ mm}$$

$$\Sigma M_A = 0: \quad \mathbf{r}_{B/A} \times \mathbf{B} + \mathbf{r}_{G/A} \times \mathbf{T} + \mathbf{r}_{G/A} \times (-W\mathbf{j}) = 0$$

$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -600 & 400 & 150 \\ B & 0 & 0 \end{vmatrix} + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -300 & 200 & 75 \\ -300 & 200 & -225 \end{vmatrix}\frac{T}{425} + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -300 & 200 & 75 \\ 0 & -98.1 & 0 \end{vmatrix}$$

Coefficient of $\mathbf{i}$: $\quad (-105.88 - 35.29)T + 7357.5 = 0$

$$T = 52.12\text{ N}$$

$T = 52.1\text{ N}$ ◀

PROBLEM 4.132 (Continued)

(*b*)

Coefficient of $\mathbf{j}$: $150B - (300 \times 75 + 300 \times 225)\dfrac{52.12}{425} = 0$

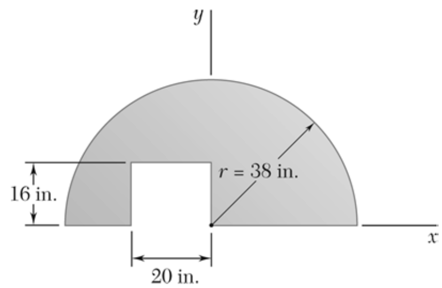
$B = 73.58$ N $\qquad \mathbf{B} = (73.6 \text{ N})\mathbf{i}$ ◀

$\Sigma\mathbf{F} = 0$: $\mathbf{A} + \mathbf{B} + \mathbf{T} - W\mathbf{j} = 0$

Coefficient of $\mathbf{i}$: $A_x + 73.58 - 52.15\dfrac{300}{425} = 0$ $\qquad A_x = -36.8$ N ◀

Coefficient of $\mathbf{j}$: $A_y + 52.15\dfrac{200}{425} - 98.1 = 0$ $\qquad A_y = 73.6$ N ◀

Coefficient of $\mathbf{k}$: $A_z - 52.15\dfrac{225}{425} = 0$ $\qquad A_z = 27.6$ N ◀



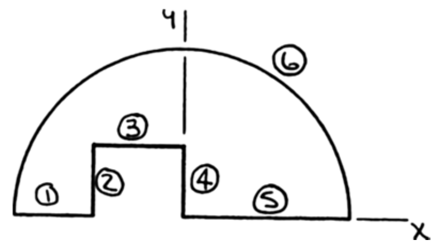
PROBLEM 5.27

A thin, homogeneous wire is bent to form the perimeter of the figure indicated. Locate the center of gravity of the wire figure thus formed.

SOLUTION

First note that because the wire is homogeneous, its center of gravity will coincide with the centroid of the corresponding line.

$$\bar{Y}_6 = \frac{2}{\pi}(38 \text{ in.})$$



	L, in.	$\bar{x}$, in.	$\bar{y}$, in.	$\bar{x}L$, in.^{2}	$\bar{y}L$, in.^{2}
1	18	–29	0	–522	0
2	16	–20	8	–320	128
3	20	–10	16	–200	320
4	16	0	8	0	128
5	38	19	0	722	0
6	$\pi(38) = 119.381$	0	24.192	0	2888.1
Σ	227.38			–320	3464.1

Then $\bar{X} = \dfrac{\Sigma \bar{x} L}{\Sigma L} = \dfrac{-320}{227.38}$ $\quad\bar{X} = -1.407$ in. ◀

$\bar{Y} = \dfrac{\Sigma \bar{y} L}{\Sigma L} = \dfrac{3464.1}{227.38}$ $\quad\bar{Y} = 15.23$ in. ◀