PROBLEM 3.105

The weights of two children sitting at ends A and B of a seesaw are 84 lb and 64 lb, respectively. Where should a third child sit so that the resultant of the weights of the three children will pass through C if she weighs (a) 60 lb, (b) 52 lb.

SOLUTION

(a) For the resultant weight to act at C, \( \Sigma M_C = 0 \) \( W_C = 60 \) lb

Then

\[
(84 \text{ lb})(6 \text{ ft}) - 60 \text{ lb}(d) - 64 \text{ lb}(6 \text{ ft}) = 0
\]

\[ d = 2.00 \text{ ft to the right of } C \]

(b) For the resultant weight to act at C, \( \Sigma M_C = 0 \) \( W_C = 52 \) lb

Then

\[
(84 \text{ lb})(6 \text{ ft}) - 52 \text{ lb}(d) - 64 \text{ lb}(6 \text{ ft}) = 0
\]

\[ d = 2.31 \text{ ft to the right of } C \]
PROBLEM 3.113

A truss supports the loading shown. Determine the equivalent force acting on the truss and the point of intersection of its line of action with a line drawn through Points $A$ and $G$.

SOLUTION

We have $\mathbf{R} = \mathbf{\Sigma F}$

$$\mathbf{R} = (240 \text{ lb})(\cos 70^\circ \mathbf{i} - \sin 70^\circ \mathbf{j}) - (160 \text{ lb}) \mathbf{j}$$

$$+ (300 \text{ lb})(-\cos 40^\circ \mathbf{i} - \sin 40^\circ \mathbf{j}) - (180 \text{ lb}) \mathbf{j}$$

$$\mathbf{R} = -(147.728 \text{ lb}) \mathbf{i} - (758.36 \text{ lb}) \mathbf{j}$$

$$R = \sqrt{R_x^2 + R_y^2}$$

$$= \sqrt{(147.728)^2 + (758.36)^2}$$

$$= 772.62 \text{ lb}$$

$$\theta = \tan^{-1} \left( \frac{R_y}{R_x} \right)$$

$$= \tan^{-1} \left( \frac{-758.36}{-147.728} \right)$$

$$= 78.977^\circ$$

or $\mathbf{R} = 773 \text{ lb} \searrow 79.0^\circ$ \triangleleft

We have $\Sigma M_A = dR_y$

where $\Sigma M_A = -[240 \text{ lb} \cos 70^\circ](6 \text{ ft}) - [240 \text{ lb} \sin 70^\circ](4 \text{ ft})$

$$- (160 \text{ lb})(12 \text{ ft}) + [300 \text{ lb} \cos 40^\circ](6 \text{ ft})$$

$$- [300 \text{ lb} \sin 40^\circ](20 \text{ ft}) - (180 \text{ lb})(8 \text{ ft})$$

$$= -7232.5 \text{ lb} \cdot \text{ ft}$$

$$d = \frac{-7232.5 \text{ lb} \cdot \text{ ft}}{-758.36 \text{ lb}}$$

$$= 9.5370 \text{ ft}$$

or $d = 9.54 \text{ ft}$ to the right of $A$ \triangleleft
PROBLEM 3.115

A machine component is subjected to the forces and couples shown. The component is to be held in place by a single rivet that can resist a force but not a couple. For \( P = 0 \), determine the location of the rivet hole if it is to be located (a) on line \( FG \), (b) on line \( GH \).

SOLUTION

We have

First replace the applied forces and couples with an equivalent force-couple system at \( G \).

Thus

\[
\Sigma F_x: \quad 200 \cos 15^\circ - 120 \cos 70^\circ + P = R_x
\]

or

\[
R_x = (152.142 + P) \text{ N}
\]

\[
\Sigma F_y: \quad -200 \sin 15^\circ - 120 \sin 70^\circ - 80 = R_y
\]

or

\[
R_y = -244.53 \text{ N}
\]

\[
\Sigma M_G: \quad -(0.47 \text{ m})(200 \text{ N})\cos 15^\circ + (0.05 \text{ m})(200 \text{ N})\sin 15^\circ \\
+ (0.47 \text{ m})(120 \text{ N})\cos 70^\circ - (0.19 \text{ m})(120 \text{ N})\sin 70^\circ \\
- (0.13 \text{ m})(P \text{ N}) - (0.59 \text{ m})(80 \text{ N}) + 42 \text{ N} \cdot \text{m} + 40 \text{ N} \cdot \text{m} = M_G
\]

or

\[
M_G = -(55.544 + 0.13P) \text{ N} \cdot \text{m}
\]  \( \text{(1)} \)

Setting \( P = 0 \) in Eq. (1):

Now with \( R \) at \( I \)

\[
\Sigma M_G: \quad -55.544 \text{ N} \cdot \text{m} = -a(244.53 \text{ N})
\]

or

\[
a = 0.227 \text{ m}
\]

and with \( R \) at \( J \)

\[
\Sigma M_G: \quad -55.544 \text{ N} \cdot \text{m} = -b(152.142 \text{ N})
\]

or

\[
b = 0.365 \text{ m}
\]

(a) The rivet hole is 0.365 m above \( G \).

(b) The rivet hole is 0.227 m to the right of \( G \).