We want \( F_{AB} + F_{AC} = F_J \) (vertical component only)

This means \( F_{AB_x} = F_{AC_x} \)

\[
F_{AB_x} = \frac{5g}{\sqrt{160^2 + 60^2}} = B \cdot \frac{40}{\sqrt{160^2 + 60^2}}
\]

\[
 F_{AC_x} = \frac{8(40)}{\sqrt{160^2 + 60^2}}
\]

or \( T = 6.4 \sqrt{161} = 56.8 \text{ kN} \)

\[ R = 10.21 \text{ kN} \]

\[ \sum M_0 = -8 \times (13^\circ) - 6 \times (6 \sin 55^\circ) \]

\[ = -128.6 \text{ kN} \]

If biceps resists

\[ \sum Y_0 \cdot \hat{z} = 0 = -128.6 + 2T \]

\[ T = 64.3 \text{ kN} \]
\[ N + F = R \]

To find \( F \):

\[ \frac{F}{N} = \tan 15 \]

\[ F = N \tan 15 = 1875 \text{ N} \]

\[ R = \sqrt{7000^2 + 1875^2} = 7250 \text{ N} \]

\[ M_y = F_y + N \times x \quad \text{since} \quad F \quad \text{is only} \quad x \quad \text{and only} \quad y \]

\[ M_y = 7940 \text{ N.m} \quad \text{CW} \]

\[ \mathbf{R} = \sum \mathbf{F} = \mathbf{A} + \mathbf{F} + \mathbf{N} = 60\hat{\mathbf{z}} - 500\hat{\mathbf{j}} + 600\hat{\mathbf{j}} - 100\hat{\mathbf{j}} - 40\hat{\mathbf{z}} \]

\[ \mathbf{R} = 20\hat{\mathbf{z}} \text{ ft} \]

Where should \( \mathbf{R} \) be placed to give the same \( \mathbf{M} \)?

\( \mathbf{M}_b = \mathbf{R} \times \mathbf{R} = (x\hat{\mathbf{i}} + y\hat{\mathbf{j}}) \times 20\hat{\mathbf{z}} \)

\[ -50\hat{\mathbf{z}} + 2\hat{\mathbf{z}} = -48\hat{\mathbf{z}} = -20y \hat{\mathbf{z}} \implies y = 2.4 \text{ ft} \]
2/92 The pedal-chainwheel unit of a bicycle is shown in the figure. The left foot of the rider exerts the 40-lb force, while the use of toe clips allows the right foot to exert the nearly upward 20-lb force. Determine the equivalent force-couple system at point 0. Also, determine the equation of the line of action of the system resultant treated as a single force R. Treat the problem as two-dimensional.

Goal: Find R and line of action for no moment.

Find x- and y-components of individual forces:

\[ F_{Ax} = 20 \text{ lb} \cdot \sin 5^\circ = 1.74 \text{ lb}, \]
\[ F_{Ay} = 20 \text{ lb} \cdot \cos 5^\circ = 19.92 \text{ lb}, \]
\[ F_{Bx} = 40 \text{ lb} \cdot \sin 15^\circ = 10.35 \text{ lb}, \]
\[ F_{By} = 40 \text{ lb} \cdot \cos 15^\circ = -38.64 \text{ lb}. \]

Now find resultant as sum of individual forces:

\[ R_x = 2F_y = 1.74 \text{ lb} + 10.35 \text{ lb} = 12.09 \text{ lb}, \]
\[ R_y = 2F_y = 19.92 \text{ lb} - 38.64 \text{ lb} = -18.72 \text{ lb}. \]

In vector form, we see:

\[ R = (12.09 \text{ lb}, -18.72 \text{ lb}) \text{ lb}. \]

Now determine moment about 0:

\[ M_0 = \sum (F_i \times \delta_i) \]
\[ M_0 = [6.5 \text{ in} \cdot (\cos 30^\circ \delta - \sin 30^\circ \delta)] \times 20 \text{ lb} \cdot (\sin 30^\circ \delta + \cos 30^\circ \delta)] \]
\[ + [6.5 \text{ in} \cdot (\cos 30^\circ \delta + \sin 30^\circ \delta)] \times 40 \text{ lb} \cdot (\sin 15^\circ \delta - \cos 15^\circ \delta)] \]
\[ = (-106.5 \text{ in} \cdot \delta - 251.1 \text{ lb}) \text{ in} \cdot \text{lb}. \]

\[ M_0 = (-35.7 \text{ lb} \cdot \delta) \text{ in} \cdot \text{lb}. \]

Continued
Find points D where equivalent moment = 0

\[ M_0 = \sum q_0 \times R + M_0 \]
\[ \sum q_0 \times R = -M_0 \]
Here, \( \sum q_0 = -\sum o_0 \)
\[ \sum o_0 \times R = +M_0 \]
\[ \sum o_0 = x^\parallel + y^\parallel \]

Now, we can solve for the line of action where \( M_0 = 0 \).

\[ S_{x0} \times R = -M_0 \]
\[ (x^C + y^C) \times (12.09x - 18.72y) \text{lb} = (-357.6 \text{lb}) \text{in}. \]
\[ (-18.72x - 12.09y) \text{lb} = (-357.6 \text{lb}) \text{in}. \]
Thus, equation of line is:
\[ (-18.72x - 12.09y) = (-357.6 \text{lb}) \text{in}. \]

Note: \( x \) and \( y \) in equation of line carry units of length (i.e., inches).

Line of action in a different form is
\[ x = 19.1 \text{ in} - 0.65 \text{ y} \]

Here, we see that the slope of the line of action is the direction of \( R \).