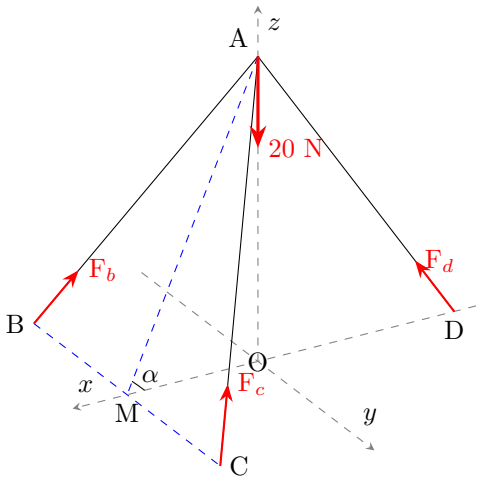
Problem

The two front legs of a tripod are 1.4 m long, with feet 0.8 m apart. The third leg is 1.5 m long and its foot is 1.5 m directly behind the mid-point of the line joining the other two. Find the height of the tripod, and the vectors representing the positions of its three feet relative to the top. Given that the tripod carries a weight of mass 2 kg, find the forces in the legs, assuming that they are purely compressional (*i.e.*, along the direction of the leg) and that the legs themselves have negligible weight. (Take $g = 10ms^{-1}$.)

Solution

$$\begin{aligned} AM^2 &= AB^2 - BM^2 \\ &= 1.4^2 - 0.4^2 \\ AM &= 1.34 \\ cos\,\alpha &= \frac{AM/2}{1.5} \quad \text{(AD=MD)} \\ &= .4472 \\ \alpha &= 63.4^\circ \\ AO &= AM\, sin\, 63.4^\circ \\ &= 1.2 \end{aligned}$$



The height of the tripod is 1.2 m.

$$\begin{aligned} OD^2 &= AD^2 - AO^2 \\ &= 2.25 - 1.44 \\ OD &= 0.9 \\ \text{and} \quad MO &= 0.6 \end{aligned}$$

Relative to the vertex A, the vectors representing the three feet are $\mathbf{b} = (.6, -.4, -1.2)$ $\mathbf{c} = (.6, .4, -1.2)$ and $\mathbf{d} = (-.9, 0, -1.2)$

Resolving the forces at A in the x, y and z directions respectively

$$\begin{aligned} \frac{.6}{1.4} F_b + \frac{.6}{1.4} F_c &= \frac{.9}{1.5} F_d \\ \frac{.4}{1.4} F_b &= \frac{.4}{1.4} F_c \\ \frac{1.2}{1.4} F_b + \frac{1.2}{1.4} F_c + \frac{1.2}{1.5} F_d &= 20 \end{aligned}$$

From equation (2) $F_b = F_c$, then from (1) $F_b = F_c = .7F_d$ and substituting in (3) gives $F_d = 10$, so $F_b = F_c = 7$.

Hence forces in the two shorter legs are 7N and in the longer leg 10N.
