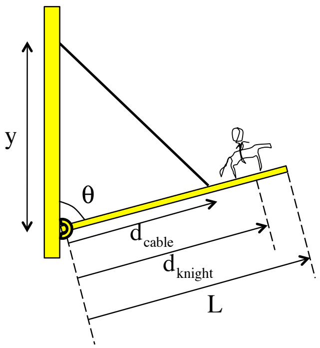
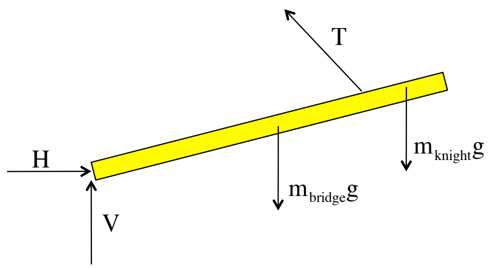
Problem 12.19

A knight on a horse gets stranded as shown on a draw bridge.

a.) Determine the tension in the cable.

As was mentioned in the previous problem, we will assume a horizontal and vertical force component acting at the pin yielding the f.d.b. show below.



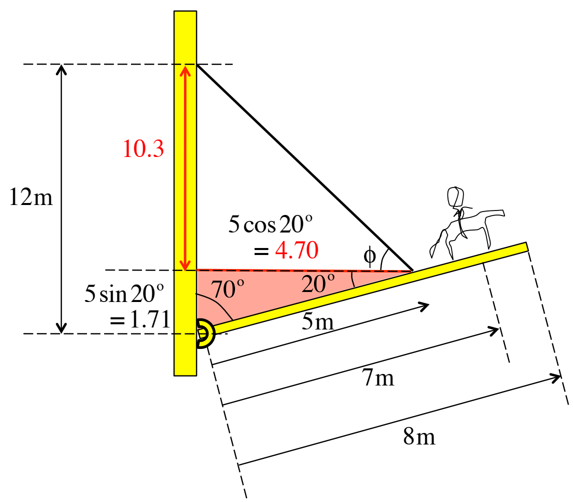


We need to know the angle between the cable and the beam. This is going to require some trickery. Consider the sketch shown below:

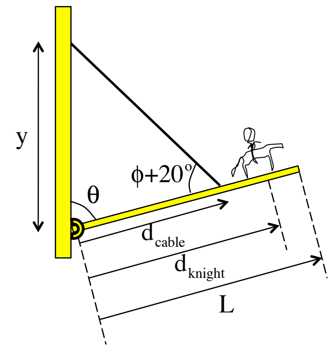
If you start by defining the triangle shown in red, all the other information falls out naturally (it was a free-for-all, but it fell out eventually). With all that final information, we can write:

$$\tan\phi = \frac{10.3}{4.70}$$

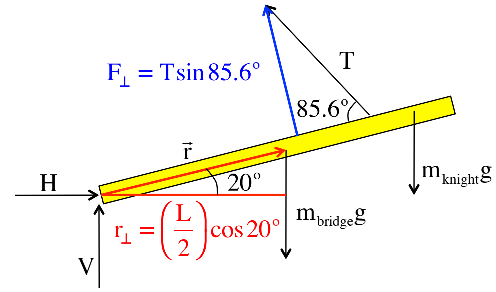
$$\Rightarrow \quad \phi = 65.5^\circ$$



With that angle (see new sketch to right), we can eliminate the *H* and *V* unknowns by summing the torques about the pin. Notice that we could use the $F_\perp$ approach by observing that the component of the tension perpendicular to the beam is $T\left(\sin\left(\phi+20^\circ\right)\right)$. All the additional information needed to sum the torques is shown in the sketch below



$$\phi+20^\circ = 65.6^\circ + 20^\circ$$
$$= 85.6^\circ$$



With all the information provided on the previous page and omitting units to save space, we can write:

$\sum \Gamma_{pin}$:

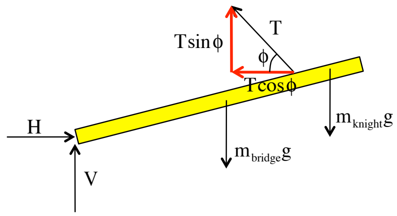
$$-m_b g\left(\frac{L}{2}\cos 20^\circ\right) - m_K g\left(d_K \cos 20^\circ\right) + \left(T\sin 85.6^\circ\right)d_C = I_{floor}\alpha^{\,0}$$

$$\Rightarrow \quad T = \frac{m_b g\left(\frac{L}{2}\sin 20^\circ\right) + m_K g\left(d_K \sin 20^\circ\right)}{d_C \sin 85.6^\circ}$$

$$= \frac{\left(2.00\text{x}10^3\right)(9.80)\left[\left(\frac{8.00}{2}\right)\cos 20^\circ\right] + \left(1.00\text{x}10^3\right)(9.80)\left[(7.00)\cos 20^\circ\right]}{(5.00)\sin 85.6^\circ}$$

$$= 2.77\text{x}10^4 \text{ N}$$

b.) Determine *H*:



$$\underline{\sum F_x :}$$

$$H - T\cos\phi = m\cancel{a_x}^{\,0}$$

$$\Rightarrow \quad H = \left(2.77\text{x}10^4 \text{ N}\right)\cos 65.5^\circ$$

$$= 1.15\text{x}10^4 \text{ N}$$

c.) Determine *V*:

$$\underline{\sum F_y :}$$

$$V - m_{bridge}g - m_{knight}g + T\sin\phi = m\cancel{a_y}^{\,0}$$

$$\Rightarrow \quad V = m_{bridge}g + m_{knight}g - T\sin\phi$$

$$= \left(2.00\text{x}10^3 \text{ kg}\right)\left(9.80 \text{ m/s}^2\right) + \left(1.00\text{x}10^3 \text{ kg}\right)\left(9.80 \text{ m/s}^2\right) - \left(2.77\text{x}10^4 \text{ N}\right)\sin 65.5^\circ$$

$$= 4.19\text{x}10^3 \text{ N}$$