

23. The beam is in equilibrium: the sum of the forces and the sum of the torques acting on it each vanish. As we see in the figure, the beam makes an angle of 60° with the vertical and the wire makes an angle of 30° with the vertical.

- (a) We calculate the torques around the hinge. Their sum is $TL \sin 30^\circ - W(L/2) \sin 60^\circ = 0$. Here W is the force of gravity acting at the center of the beam, and T is the tension force of the wire. We solve for the tension:

$$T = \frac{W \sin 60^\circ}{2 \sin 30^\circ} = \frac{(222 \text{ N}) \sin 60^\circ}{2 \sin 30^\circ} = 192.3 \text{ N} .$$

- (b) Let F_h be the horizontal component of the force exerted by the hinge and take it to be positive if the force is outward from the wall. Then, the vanishing of the horizontal component of the net force on the beam yields $F_h - T \sin 30^\circ = 0$ or

$$F_h = T \sin 30^\circ = (192.3 \text{ N}) \sin 30^\circ = 96.1 \text{ N} .$$

- (c) Let F_v be the vertical component of the force exerted by the hinge and take it to be positive if it is upward. Then, the vanishing of the vertical component of the net force on the beam yields $F_v + T \cos 30^\circ - W = 0$ or

$$F_v = W - T \cos 30^\circ = 222 \text{ N} - (192.3 \text{ N}) \cos 30^\circ = 65.5 \text{ N} .$$