Homework 1

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Force Statics

1 Book

1.1 5.2

(a)

$$\begin{aligned} \sum F_y &= 0 \\ T_{\text{wall, b}} - w_b &= 0 \\ T_{\text{wall, b}} &= w_b \end{aligned}$$

$$\boxed{T_{\text{wall, b}} = w_b}$$

(b)

$$\begin{aligned} \sum F_y^{(b_1)} &= 0 \\ T_{b_2,b_1} - w_{b_1} &= 0 \\ T_{b_2,b_1} &= w_{b_1} \\ \sum F_y^{(b_2)} &= 0 \\ T_{b_1,b_2} - w_{b_2} &= 0 \\ T_{b_1,b_2} &= w_{b_2} \\ T_{b_2,b_1} + T_{b_1,b_2} &= w_{b_1} + w_{b_2} \end{aligned}$$

where

$$T_{b_1,b_2} = T_{b_2,b_1} \ \ \& \ \ w_{b_1} = w_{b_2}$$

$$\begin{aligned} T + T &= w + w \\ 2T &= 2w \\ T &= w \end{aligned}$$

$$\boxed{T = w}$$

(c)

$$\begin{aligned}
\sum F_y^{(b_1)} &= 0 \\
T_{b_2,b_1} - w &= 0 \\
T_{b_2,b_1} &= w \\
\sum F_y^{(b_2)} &= 0 \\
T_{b_1,b_2} - w &= 0 \\
T_{b_1,b_2} &= w
\end{aligned}$$

where

$$T_{b_1,b_2} = T_{b_2,b_1}$$

$$\begin{aligned}
T + T &= w + w \\
2T &= 2w \\
T &= w
\end{aligned}$$

$$\boxed{T = w}$$

1.2 5.6

$$\begin{aligned}
b &= \text{ball} \\
m &= 3620\,\mathrm{kg} \\
\theta_{T_B,\hat{y}} &= 40^\circ
\end{aligned}$$

(a)

$$\begin{aligned}
T_B &= ? \\
\cos(\theta) &= \frac{m_b g}{T_B} \\
T_B &= \frac{m_b g}{\cos(\theta)} \\
&= \frac{3620\,\mathrm{kg} \cdot 10\,\mathrm{m\,s^{-2}}}{\cos(40^\circ)} \\
T_B &= 47\,255.7\,\mathrm{N}
\end{aligned}$$

$$\boxed{T_B = 47.3 \times 10^3\,\mathrm{N}}$$

(b)

$$
\begin{aligned}
T_A &= ? \\
\theta_{T_B,\hat{x}} &= ? \\
\theta_{T_B,\hat{x}} &= 90^\circ - \theta_{T_B,\hat{y}} \\
&= 90^\circ - 40^\circ \\
\theta_{T_B,\hat{x}} &= 50^\circ \\
\cos(\theta_{T_B,\hat{x}}) &= \frac{T_{B_x}}{T_B} \\
T_{B_x} &= (T_B)\cos(\theta_{T_B,\hat{x}}) \\
&= \left(47.3 \times 10^3\,\mathrm{N}\right)\cos(50^\circ) \\
T_{B_x} &= 30\,403.9\,\mathrm{N} \\
\sum F_x^{(b)} &= 0 \\
T_{B_x} - T_A &= 0 \\
T_A &= T_{B_x} \\
T_A &= 30\,403.9\,\mathrm{N}
\end{aligned}
$$

$$\boxed{T_A = 30.4 \times 10^3\,\mathrm{N}}$$

1.3 5.62

$$
\begin{aligned}
T_{r,p_1} &= ? \\
T_{w,p_1} &= ? \\
w &= m_w g \\
T_{p_2,p_1} &= ? \\
T_{r,p_2} &= ? \\
\vec{F} &= ?
\end{aligned}
$$

Based on the free body diagrams, it can be concluded that

$$T_{r,p_1} = T_{p_2,p_1} = \vec{F} \tag{1}$$

as they share a common rope.

Therefore the forces of p_1 in the $\hat{y}$ direction can be found as

$$
\begin{aligned}
\sum F_y^{(p_1)} &= 0 \\
T_{r,p_1} + T_{p_2,p_1} - T_{w,p_1} &= 0 \\
T_{w,p_1} &= 2T
\end{aligned}
$$

Finding $T_{p_1,w}$ from the free body diagram of the weight

$$\begin{aligned}\sum F_y^{(\text{weight})} &= 0\\ T_{p_1,w} - w &= 0\\ T_{p_1,w} &= w\end{aligned}$$

In order to withhold Newton's third law, the combined tension of T_{r,p_1} and T_{p_2,p_1} must equal T_{w,p_1} (as shown in Equation 1)

$$\begin{aligned}2T &= T_{w,p_1}\\ &= w\\ T &= \frac{w}{2}\end{aligned}$$

It can therefore be concluded that (according to *(1)*) $\vec{F}$ must equal T, finding the magnitude in terms of w

$$\boxed{\vec{F} = T = \frac{w}{2}}$$

1.4 5.64

1.5 5.79

2 Lab Manuel

2.1 270

2.2 273

2.3 274

2.4 287

2.5 290