

Homework 3

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Torque Statics

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1 Book

1.1 11.14

(a)

(b)

$$\begin{aligned}
 l_b &= 9.00 \text{ m} \\
 w_b &= 300 \text{ N} \\
 x_{B,A} &= 5.00 \text{ m} \\
 w_p &= 600 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 \sum \tau_{\star} &= 0 \\
 (F_A)(5 \text{ m}) &= (w_p)(5 \text{ m} - x) + (w_b)(2.5 \text{ m}) \\
 F_A &= (0.2 \text{ m}^{-1}) ((600 \text{ N})(5 \text{ m} - x) + (300 \text{ N})(2.5 \text{ m})) \\
 (0) &= 600 \text{ N} - (120 \text{ N m}^{-1})x + 150 \text{ N} \\
 (120 \text{ N m}^{-1})x &= 750 \text{ N} \\
 x &= 6.25 \text{ m}
 \end{aligned}$$

$$x = 6.25 \text{ m} - x_{B,A} = 1.25 \text{ m}$$

$$\boxed{1.25 \text{ m}}$$

(c)

$$x_{\text{p}} = 7.00 \text{ m}$$

$$w_{\text{p}} = 600 \text{ N}$$

$$x_{\text{b}} = 2.5 \text{ m}$$

$$w_{\text{b}} = 300 \text{ N}$$

$$x_{\text{B}} = ?$$

$$F_{\text{B}} = 900 \text{ N}$$

$$x_{\text{A}} = 0$$

$$F_{\text{A}} = 0$$

$$\sum \tau_{\star} = 0$$

$$(w_{\text{b}})(x_{\text{b}}) + (w_{\text{p}})(x_{\text{p}}) = (F_{\text{b}})(x_{\text{b}})$$

$$x_{\text{b}} = \frac{(300 \text{ N})(2.5 \text{ m}) + (600 \text{ N})(7.00 \text{ m})}{900 \text{ N}}$$

$$x_{\text{b}} = 1.5 \text{ m}$$

$$\boxed{x_{\text{b}} = 1.5 \text{ m}}$$

1.2 11.16

$$l_{(\text{b})\text{eam}} = 4.00 \text{ m}$$

$$l_{(\text{c})\text{able}} = 5.00 \text{ m}$$

$$l_{(\text{w})\text{all}} = 3.00 \text{ m}$$

$$w_{\text{b}} = 190 \text{ N}$$

$$w_{(\text{o})\text{bject}} = 300 \text{ N}$$

$$\theta_{\text{c,b}} = 36.87^\circ$$

(a)

$$T = ?$$

$$T_y = T \sin(\theta_{\text{c,b}})$$

$$\sum \tau_{\star} = 0$$

$$\left(\frac{l_{\text{b}}}{2}\right)(w_{\text{b}}) + (l_{\text{b}})(w_{\text{o}}) = (l_{\text{b}})(T_y)$$

$$T = \frac{\left(\frac{4.00 \text{ m}}{2}\right)(190 \text{ N}) + (4.00 \text{ m})(300 \text{ N})}{(4.00 \text{ m})(\sin(36.87^\circ))}$$

$$T = 658.3 \text{ N}$$

$$\boxed{T = 658.3 \text{ N}}$$

(b)

$$\begin{aligned}F_x &=? \\ \sum F_x &= 0 \\ F_x &= T_x \\ &= T \cos(\theta_{c,b}) \\ &= (658.3 \text{ N})(\cos(36.87^\circ)) \\ F_x &= 526.6 \text{ N}\end{aligned}$$

$$\begin{aligned}F_y &=? \\ \sum F_y &= 0 \\ F_y + T_y &= w_b + w_o \\ F_y + (658.3 \text{ N})(\sin(36.87^\circ)) &= 190 \text{ N} + 300 \text{ N} \\ F_y &= 190 \text{ N} + 300 \text{ N} - (658.3 \text{ N})(\sin(36.87^\circ)) \\ F_y &= 95.02 \text{ N}\end{aligned}$$

$$\boxed{F_x = 526.6 \text{ N}, F_y = 95.02 \text{ N}}$$

1.3 11.23

$$\begin{aligned}F_1 &= F_2 = 6.30 \text{ N} \\ l_{F_1,O} &= 3.00 \text{ m}\end{aligned}$$

(a)

$$\begin{aligned}l &=? \\ \sum \tau_\star &= 6.50 \text{ N m} \\ (F_2)(l_{F_1,O} + l) &= 6.50 \text{ N m} + (F_1)(l_{F_1,O}) \\ (6.30 \text{ N})(3.00 \text{ m} + l) &= 6.50 \text{ N m} + (6.30 \text{ N})(3.00 \text{ N}) \\ l &= 1.032 \text{ m}\end{aligned}$$

$$\boxed{l = 1.032 \text{ m}}$$

(b)

$$\boxed{\text{clockwise}}$$

(c)

$$l = ?$$

$$F_2 = 0$$

$$\sum \tau_{\star} = (6.50 \text{ N m})(3.00 \text{ m} + l)$$

$$-(F_1)(l) = (6.50 \text{ N m})$$

$$-(6.30 \text{ N})(l) = (6.50 \text{ N m})$$

$$l = -1.032 \text{ m}$$

$$\boxed{l = -1.032 \text{ m}}$$

1.4 11.45

$$h = 0.300 \text{ m}$$

$$x = 0.080 \text{ m}$$

$$\theta = 60^\circ$$

$$F_1 = ?$$

$$F_2 = ?$$

$$\sum \tau_{\star} = 0$$

$$(F_2)(h) - (F_1 \sin \theta)(x) = 0$$

$$(F_2)(0.300 \text{ m}) = (F_1 \sin(60^\circ))(0.080 \text{ m})$$

$$F_1 = F_2(4.330)$$

$$\boxed{F_1 = F_2(4.330)}$$

1.5 11.49

$$\theta = 25.0^\circ$$

$$\phi = 35.0^\circ$$

$$l_{\text{cog}} = 1.1 \text{ m}$$

$$w_{\text{p}} = 82.0 \text{ kg}$$

$$l_{(\text{h})\text{ands}} = 1.40 \text{ m}$$

$$l_{(\text{p})\text{erson}} = 1.90 \text{ m}$$

(a)

$$T = ?$$

$$\cos(\phi) = \frac{l_{\text{cog}_x}}{l_{\text{cog}}}$$

$$l_{\text{cog}_x} = (1.1 \text{ m})(\cos(35.0^\circ))$$

$$l_{\text{cog}_x} = 0.9011 \text{ m}$$

$$\psi = 90^\circ - \phi$$

$$= 90^\circ - 35.0^\circ$$

$$\psi = 55.0^\circ$$

$$\sin(\psi) = \frac{l_{h_x}}{l_h}$$

$$l_{h_x} = (1.40 \text{ m})(\sin(55.0^\circ))$$

$$l_{h_x} = 1.147 \text{ m}$$

$$\cos(\theta) = \frac{T_y}{T}$$

$$T_y = T \cos(\theta)$$

$$\sum \tau_\star = 0$$

$$(w_p)(l_{\text{cog}_x}) = (l_{h_x})(T \cos(\theta))$$

$$T = \frac{(82.0 \text{ kg})(10 \text{ m s}^{-2})(0.9011 \text{ m})}{(1.147 \text{ m})(\cos(25.0^\circ))}$$

$$T = 710.1 \text{ N}$$

1.6 11.53

1.7 11.71

1.8 11.75

1.9 11.81

2 Lab Manual

2.1 370

2.2 372