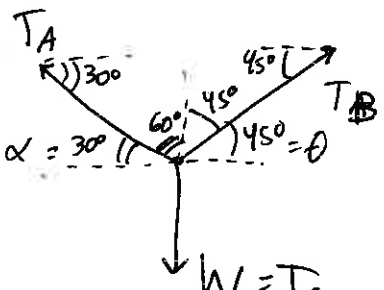
5.7

a) 

↑ get this with logic or an FBD of the lamp.

$$T_{AC} = W$$

X-forces

$+ T_B \cos 45°$

$- T_A \cos 30°$

$\sum F_x = ma_x$

$T_B \cos 45° - T_A \cos 30 = 0$

$T_B \cos 45 = T_A \cos 30$

$T_B = T_A \frac{\cos 30}{\cos 45}$

Y-forces

$+ T_B \sin 45°$ (or $\cos 45°$)

$+ T_A \sin 30°$ (or $\cos 60°$)

$- T_C = W$

$\sum F_y = ma_y$

$T_B \sin 45° + T_A \sin 30 = W$

$T_A \frac{\cos 30}{\cos 45} \sin 45 + T_A \sin 30 = W$

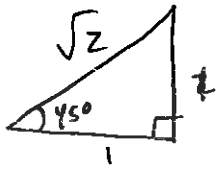
$T_A \cos 30 \tan 45 + T_A \sin 30 = W$

$T_A (\cos 30 \tan 45 + \sin 30) = W$

$$T_A = W(\cos 30° \tan 45° + \sin 30°)^{-1}$$

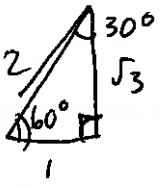
$$T_B = W\left(\frac{\cos 30^\circ}{\cos 45^\circ}\right)\left(\cos 30^\circ \tan 45^\circ + \sin 30^\circ\right)^{-1}$$

can simplify by using values on right or calculator.



$\cos 45^\circ = \frac{1}{\sqrt{2}}$

$\tan 45^\circ = 1$

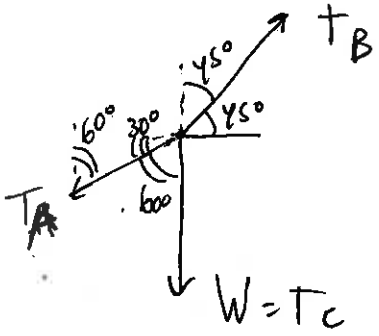


$\cos 30^\circ = \frac{2}{\sqrt{3}}$

$\sin 30^\circ = \frac{2}{1}$

---

b)



$T_{bC} = W$ by logic or FBD

X-forces

$+T_B \cos 45^\circ$

$-T_A \cos 30^\circ$

$T_B \cos 45^\circ = T_A \cos 30^\circ$

$T_B = T_A \frac{\cos 30^\circ}{\cos 45^\circ}$

y-forces

$-W$

$+T_B \cos 45^\circ$

$-T_A \cos 60^\circ$

$T_B \cos 45^\circ = W + T_A \cos 60^\circ$

$T_A \cos 30^\circ \cdot \frac{\cos 45^\circ}{\cos 45^\circ} = W + T_A \cos 60^\circ$

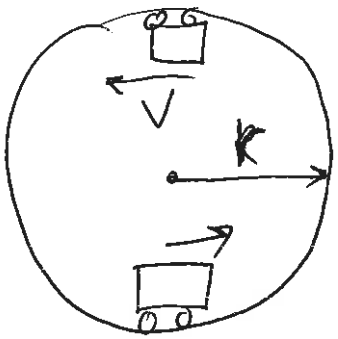
$$T_A \cos 30° - T_A \cos 60° = W$$

$$\boxed{T_A = \frac{W}{\cos 30° - \cos 60°}}$$

$$\boxed{T_B = \frac{\cos 30°}{\cos 45°} W(\cos 30° - \cos 60°}$$

Sanity check: ① Units? ② Do you expect T_A & T_B to be $> W$ or $< W$? Are they?

5.42



↓ gravity

$m = 0.800\,kg$

$V = 12.0\,m/s$

$r = 5.00\,m$

a) Centripetal accel is always

$$a_c = \frac{V^2}{r} = \frac{12^2}{5} = \boxed{28.8\,m/s^2}$$

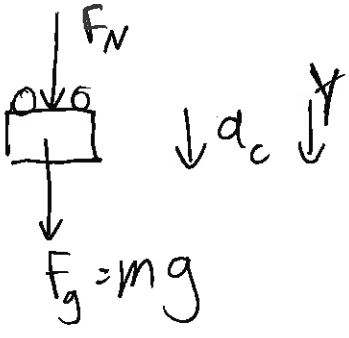
b) "Net force causes accel" or
Net force provides accel.

$$\Sigma F = m a_c$$

$$F_{Net} = m a_c$$

$$= 0.800 \cdot 28.8 = 23.04 = \boxed{23.0\,N}$$

c)



$$\Sigma F_y = m a_c$$

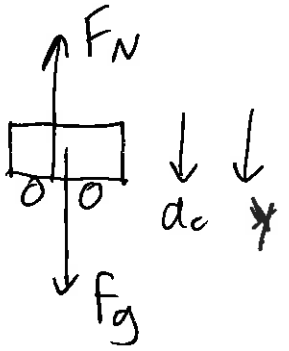
$$mg + F_N = m a_c$$

$$F_N = m a_c - mg = m(a_c - g)$$

$$= 0.800(28.8 - 9.80)$$

$$= \boxed{15.2\,N}$$

d)



$$\Sigma F_y = ma_c$$

$$F_g - F_N = ma_c$$

$$mg - F_N = ma_c$$

$$F_N = ma_c + mg$$

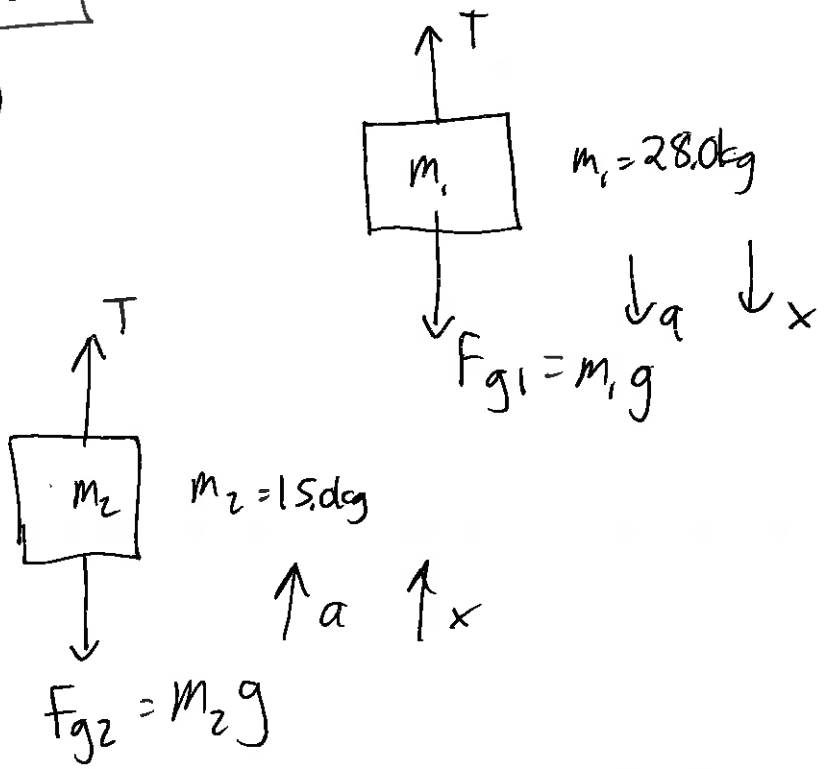
$$= m(a_c + g)$$

$$= 0.800(28.8 + 9.80)$$

$$= 30.88 = \boxed{30.9\ N}$$

5.15

a)



x-forces on 1

$+ m_1 g$

$- T$

$m_1 g - T = m_1 a$

$\leftarrow \Sigma F = ma \rightarrow$

x-forces on 2

$- m_2 g$

$+ T$

$T - m_2 g = m_2 a$

$T = m_2 a + m_2 g$ (1)

$m_1 g - m_2 a - m_2 g = m_1 a$

$m_1 g - m_2 g = m_1 a + m_2 a$

(d) $\boxed{a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g}$

b) $a = \frac{28.0 - 15.0}{28.0 + 15.0} \times 9.80 = 2.96279$

$= \boxed{2.96 \text{ m/s}^2}$

Plug in (d) answer to (1)

(1) $T = m_2 a + m_2 g$

$T = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) m_2 g + m_2 g$

$= m_2 g \left[\frac{m_1 - m_2}{m_1 + m_2} + 1\right]$

$= m_2 g \left[\frac{m_1 - m_2}{m_1 + m_2} + \frac{m_1 + m_2}{m_1 + m_2}\right]$

e) $\boxed{T = \left(\frac{2 m_1 m_2}{m_1 + m_2}\right) g}$

c) $T = \frac{2 \cdot 28.0 \cdot 15.0}{28+15.0} \cdot 9.80 = 191.44186$

$= \boxed{191\ N}$

Sanity check, T should be $< W_{Bricks}$, and $< W_{counterweight}$.

f) Sanity check on equations

$$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$$

(mass / mass) → unitless; g → accel

Units work out

when $m_1 = m_2$, $a = \frac{0}{m_1+m_2} \cdot g = 0$ yay!

$m_1 \gg m_2$ $a = \frac{m_1 - 0}{m_1 + 0} \cdot g = g$

yay!

$$T = \left(\frac{2 m_1 m_2}{m_1 + m_2}\right) g$$

$(\text{mass}^2 / \text{mass}) \rightarrow$ accel → units work

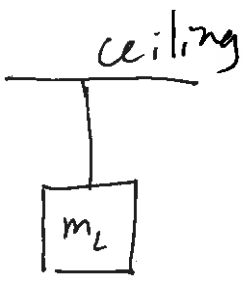
$$T = \left(\frac{2 m_1 m_2}{m_1 + m_2}\right) g$$

When $m_1 = m_2$, $T = \frac{2m^2}{2m} \cdot g$

$= mg$ yay!

$m_1 \gg m_2$ $\quad T = \frac{2 m_1 \cdot 0}{m_1 + 0} g = 0$

yay!



or

$$T = \frac{2 M_1 m_2}{M_1} g = 2 m_2 g$$

Not unreasonable.