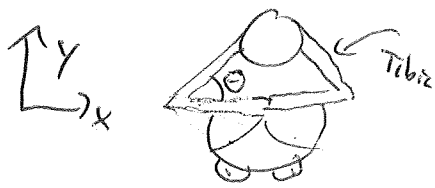
5-16 $\theta = 40°$ Insects have 6 legs.

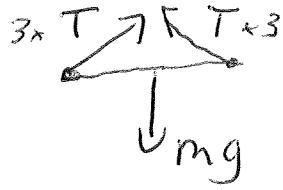



a) What's ratio of T in tibia to insect's weight?

The bug is hanging there and not moving.

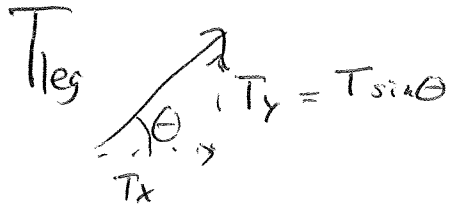
So, $\Sigma F_{net} = ma = 0$

Diagram:




In the y direction, there are 7 forces:

6 identical $T_{leg}$ y components up, and mg straight down




so: $6(T_{leg} \sin\theta) - mg = 0$

solve for $\frac{T}{mg} = \frac{1}{6\sin\theta} = \frac{1}{6\sin 40°} = 0.260$

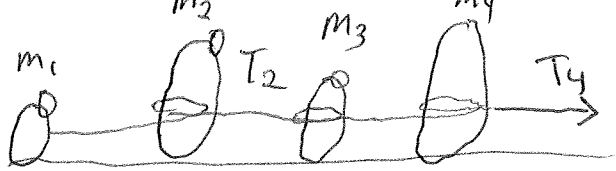
b) $T = \frac{mg}{6\sin\theta}$, so if $\theta \uparrow$, so $\sin\theta \uparrow$, and T is smaller

5-54 $m_1 = 12\ kg$

$m_2 = ?$

$m_3 = 15\ kg$

$m_4 = 20\ kg$




$T_2 = 111\ N$ $\quad T_4 = 222\ N$

Pull on $T_4$, all four move, so

(1) $F = T_4 = m_{TOT}\, a = 222\ N = (12 + m_2 + 15 + 20)\ kg\ (a)$

Pull on $T_2$, only last two move, so

(2) $F = T_2 = m_{1+2}\, a = 111\ N = (12 + m_2)\ kg\ (a)$

2 equations, 2 unknowns: $a$, $m_2$.

We don't care about "$a$". Let's solve eq. (2) for $a$, and subst into (1)

$$a = \frac{111\ N}{12\ kg + m_2} \xrightarrow{\text{Subst.}} 222 = (47\ kg + m_2)\left(\frac{111\ N}{12\ kg + m_2}\right)$$

Or $\quad \frac{222\ N}{111\ N}(12\ kg + m_2) = 47\ kg + m_2$

$$24\ kg + 2m_2 = 47\ kg + m_2$$

$$m_2 = (47\ kg - 24\ kg) = \boxed{23\ kg}$$