20080313_0847 Solution

We were not told where this happened so we do not know the value of g.

(We need to solve this in the general case instead of using g as $9.8\ m/s^2$)

$F_{w1} = m_1 g = (14.70\text{kg})g$

$F_{w2} = m_2 g$

Total mass $= m_1 + m_2 = (14.70\text{kg}) + m_2$

We also do not know which mass is larger so we do not know which way the pulley is turning.

1^{st} assume m_1 goes up.

$\boxed{F = ma}$

Newton's 2^{nd} Law

$$F_{acc} = (m_{Total})(acc)$$

$$= [(14.70\text{kg}) + (m_2)](4\ m/s^2)$$

$$F_{acc} = 58.8N + (4\ m/s^2)m_2$$

F_{acc} must be $F_{w2} - F_{w1}$

$$F_{acc} = (m_2 g) - (14.70\text{kg})g$$

(The gravitational force on the larger mass, whichever one is larger, must provide enough force to hold the smaller mass in place and it must provide any force that can cause acceleration.

$$F_{acc} = F_{acc}$$

$$(m_2 g) - (14.7\,kg)g = 58.8\,N + (4\,m/s^2)m_2$$

Solve for m_2

$$(m_2 g) - (4\,m/s^2)m_2 = \underbrace{58.8\,N}_{} + (14.7\,kg)g$$

$$(m_2)(g - 4\,m/s^2) = (14.7\,kg)(4\,m/s^2) + (14.7\,kg)g$$

$$(m_2)(g - 4\,m/s^2) = (14.7\,kg)(g + 4\,m/s^2)$$

$$\boxed{m_2 = \frac{(14.7\,kg)(g + 4\,m/s^2)}{(g - 4\,m/s^2)}}$$

The Tension in the rope must be enough to support m_1 and cause m_1 to accelerate at $4\,m/s^2$.

$$T = m_1 g + m_1(4\,m/s^2)$$

$$T = m_1(g + 4\,m/s^2)$$

$$T = (14.7\,kg)(g + 4\,m/s^2)$$

Check using $g = 9.8\,m/s^2$

$$m_2 = \frac{(14.7kg)(g + 4\,m/s^2)}{(g - 4\,m/s^2)}$$

$$m_2 = \frac{(14.7kg)(9.8\,m/s^2 + 4\,m/s^2)}{(9.8\,m/s^2 - 4\,m/s^2)}$$

$$m_2 = \frac{(14.7kg)(13.8\,m/s^2)}{(5.8\,m/s^2)}$$

$$m_2 = \frac{202.86kg}{5.8}$$

$$m_2 = 34.97586207\,Kg$$

If $m_2 = 34.97586207\,kg$ Then

$$F_{w2} = m_2 g = (34.97586207\,kg)(9.8\,m/s^2)$$

$$F_{w2} = 342.7634483\,N$$

$$F_{w1} = m_1 g = 144.06\,N$$

20080313_0847 Solution P4

IF $F_{w2} = 342.2634483 N$ an if $F_{w1} = 144.06 N$ The The force left for acceleration must be $F_2 - F_1$

$F_{ACC\ TOTAL} = 342.7634483N - 144.06N$

$F_{ACC\ TOTAL} = 198.7034483\ N$

This force should cause The total mass to accelerate at $4\ m/s^2$.

$M_{TOTAL} = m_1 + m_2$

$= 14.7kg + 34.97586207kg$

$M_{TOTAL} = 49.67586207\ kg$

$F_{acc} = (M_{TOTAL})(a) = (49.67586207kg)(4\ m/s^2)$

$F_{acc} = 198.7034483\ N$

It agrees.

20080313-0847 Solution

P5

Check The tension

$$T = (14.7\,kg)(9.8\,m/s^2 + 4\,m/s^2)$$

$$= (14.7\,kg)(13.8\,m/s^2)$$

$$\boxed{T = 202.86\,N}$$

Another way

T on ~~right~~ left side T on ~~left~~ right side

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

$$T = T$$

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

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

$$m_1 (9.8\,m/s^2 + 4\,m/s^2) = m_2 (9.8\,m/s^2 - 4\,m/s^2)$$

$$m_1 (13.8\,m/s^2) = m_2 (5.8\,m/s^2)$$

$$m_2 = \left(\frac{13.8\,m/s^2}{5.8\,m/s^2}\right) m_1$$

$$m_2 = 2.379310345\, m_1$$

$$= (\qquad)(14.7\,kg)$$

$$m_2 = 34.97586207\,kg$$

T on ~~the~~ right side

$$T = m_2 g - m_2 a$$
$$= m_2(g - a)$$
$$= m_2(9.8\,m/s^2 - 4\,m/s^2)$$
$$= m_2(5.8\,m/s^2)$$
$$= (34.97586207\,kg)(5.8\,m/s^2)$$

$$T_{Right} = 202.86\,N$$

T on left side

$$T = m_1 g + m_1 a$$
$$= m_1(g + a)$$
$$= (14.7\,kg)(9.8 + 4)\,m/s^2$$
$$T_{Right} = 202.86$$

T_{Left} must be the same as T_{Right}

They are!

Now for the case where m_2 is less than m_1

Here m_1 will drop and m_2 will rise

$$T_{Left} = T_{Right}$$

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

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

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

$$= \frac{(14.7kg)(9.8\,m/s^2 - 4\,m/s^2)}{(9.8\,m/s^2 + 4\,m/s^2)}$$

$$= \frac{(14.7kg)(5.8\,m/s^2)}{13.8\,m/s^2}$$

$$= (14.7kg)(.42028985\,5)$$

$$\boxed{m_2 = 6.17826087kg}$$

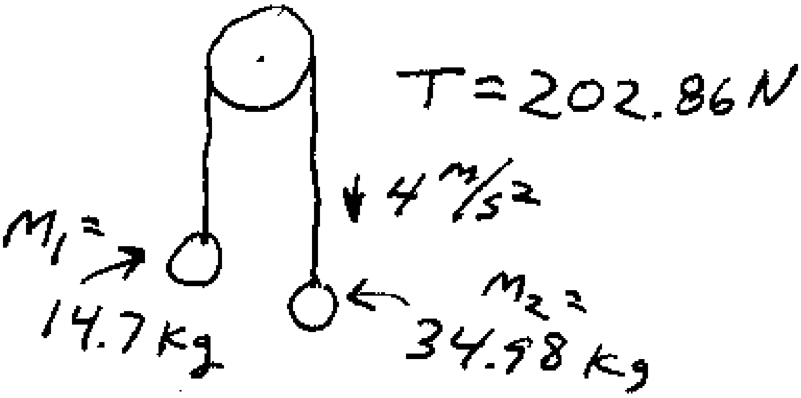
$T_{Left} = m_1 g - m_1 a = m_1(g-a) = (14.7kg)(5.8\,m/s^2) = 85.26N$

$T_{Right} = m_2 g + m_2 a = m_2(g+a) = (6.17826087kg)(13.8)(\frac{m}{s^2}) = 85.26N$

Here again the Tensions are the same

Therefore if

$$\boxed{\begin{aligned} M_2 &= \frac{m_1(g+a)}{(g-a)} \\ T &= m_1(g+a) \end{aligned}}$$



And if

$$\boxed{\begin{aligned} M_2 &= \frac{m_1(g-a)}{(g+a)} \\ T &= m_1(g-a) \end{aligned}}$$