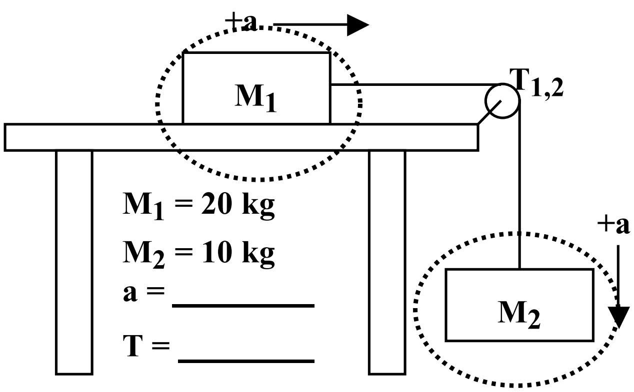
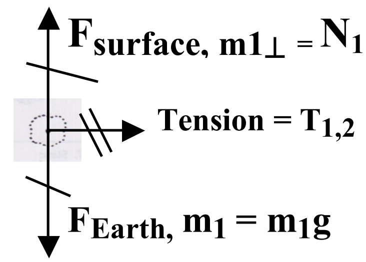
Single Body Analysis Worksheet Help

Use $T_{1,2}$ for the force between box 1 and box 2 instead of $F_{rope,\ box}$ or $F_{box1,\ box2}$.

Step 1 – Circle system for each object.
Step 2 – Define direction of acceleration for each box. Notice how it changes when it hits the pulley.



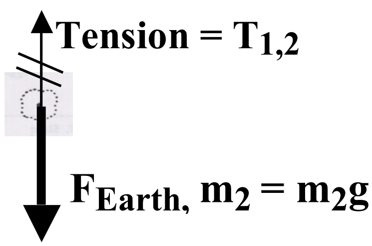
Step 3 - Force diagram for mass 1



Step 4 - Force equation for box 1 in X-direction (direction of acceleration)

$$T_{1,2} = m_1 a_x$$

Step 5 - Force diagram for mass 2



Step 6 - Force equation for box 2

$$m_2 g - T_{1,2} = m_2 a$$

Step 7 - Combine both force equations so you can find the acceleration of the system.

$\cancel{T_{1,2}}$	$= m_1 a$	**(Step 4)**
$+\ m_2 g - \cancel{T_{1,2}}$	$= m_2 a$	**(Step 6)**
$m_2 g$	$= m_1 a + m_2 a$	**Pull out the acceleration**
$m_2 g$	$= (m_1 + m_2) a$	**Divide both sides by $(m_1 + m_2)$**
$m_2 g / (m_1 + m_2)$	$= a$	**Now plug the numbers in for the masses and g.**

Step 8 – Plug thy numbers in to find acceleration.

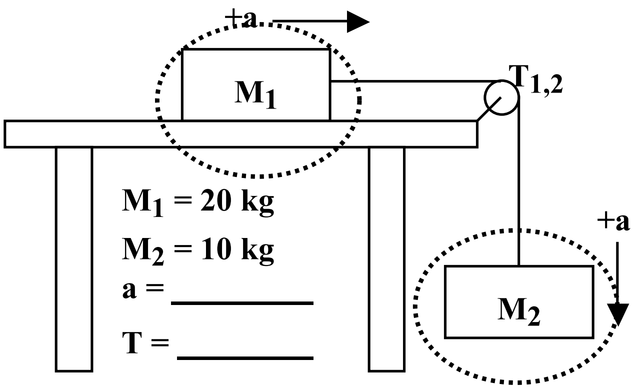
$m_2 g / (m_1 + m_2) = a$ $\qquad$ $a = (10.\ kg * 10.\ m/s^2)/(20.\ kg + 10.\ kg)$ $\qquad$ **$a = 3.3\ m/s^2$**

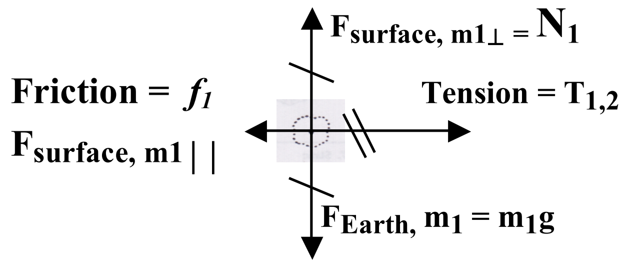
Step 9 - Now plug the value you found for acceleration into one of the F = ma equations and solve for $T_{1,2}$.

$T_{1,2} = m_1 a_x$ $\qquad$ $T_{1,2} = 20.\ kg * 3.3\ m/s^2$ $\qquad$ **$T_{1,2} = 66\ N$**

Step 4

2. Friction is present. (μ **= 0.15**) (μ **= coefficient of friction)**





Force equation for box 1 in Y-direction

$$F_{surface,\, m1\perp} - m_1g = \cancel{m_1a_y}^{\,0}$$

$$F_{surface,\, m1\perp} = m_1g \quad \textbf{Or}$$

$$N_1 = m_1g$$

Friction equation

$$F_{surface,\, m1||} = \mu * F_{surface,\, m1\perp}$$

Or $\longrightarrow$ $f_1 = \mu * N_1$

SO if Normal Force equals Weight then

$$F_{surface,\, m1||} = \mu * m_1g \qquad \textbf{or}$$

$$f_1 = \mu * m_1g$$

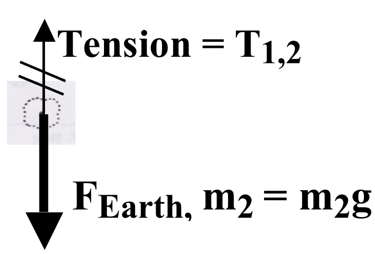
Force equation for box 1 in X-direction

$$T_{1,2} - F_{surface,\, m1||} = m_1a_x \qquad \textbf{or} \quad T_{1,2} - f_1 = m_1a_x$$

Substitute what friction is equal to in to the F=ma$_X$ equation.

$$T_{1,2} - \mu * m_1g = m_1a_x$$

Now repeat steps 5 thru 9 from the front of the page.



$$m_2g - T_{1,2} = m_2a$$

$\cancel{T_{1,2}} - \mu * m_1 g = m_1 a$

$+ m_2 g - \cancel{T_{1,2}} = m_2 a$

$m_2 g - \mu * m_1 g = m_1 a + m_2 a$

$m_2 g - \mu * m_1 g = (m_1 + m_2) a$

$(m_2 g - \mu * m_1 g) / (m_1 + m_2) = a$

$(10kg * 10.\ m/s^2 - 0.15 * 20kg * 10.\ m/s^2) / (20kg + 10kg) = a$

$(100.\ kg*m/s^2 - 30.\ kg*m/s^2) / (30.\ kg) = a$

$(70.\ \cancel{kg}*m/s^2) / (30.\ \cancel{kg}) = a$

$2.3\ m/s^2 = a$

$m_2 g - T_{1,2} = m_2 a$

$m_2 g - \cancel{T_{1,2}} + \cancel{T_{1,2}} = m_2 a + T_{1,2}$

$m_2 g = m_2 a + T_{1,2}$

$m_2 g - m_2 a = \cancel{m_2 a - m_2} a + T_{1,2}$

$m_2 g - m_2 a = T_{1,2}$

$T_{1,2} = 10kg * 10.\ m/s^2 - 10kg * 2.3\ m/s^2$

$T_{1,2} = 100\ N - 23\ N$

$T_{1,2} = 77\ N$