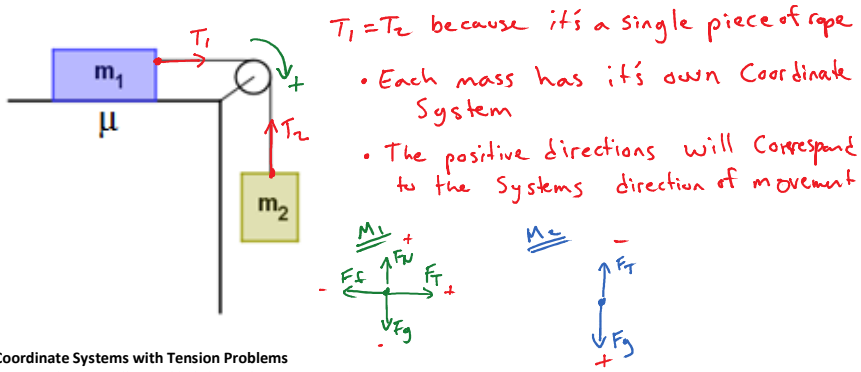
Tension Problems

February 28, 2017 8:12 AM

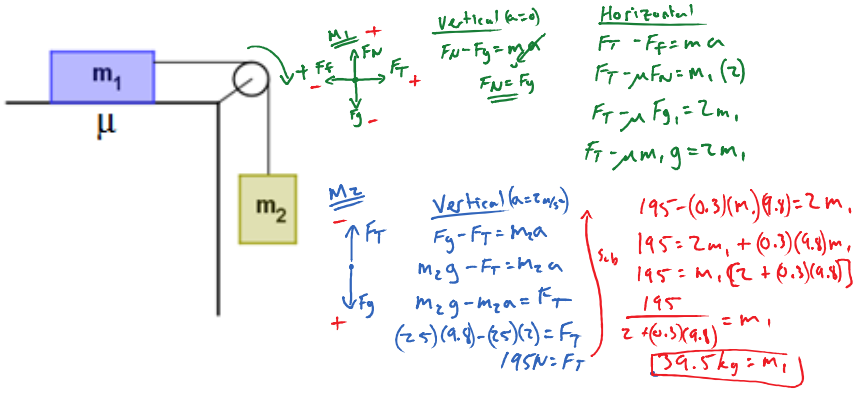
Tension Questions

Tension is a force that is transferred through a rope. The magnitude of the tension in a rope is the same all throughout. The direction of the tension pulls on the masses.



Coordinate Systems with Tension Problems

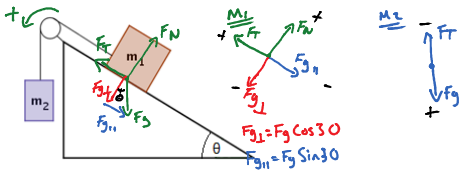
- Each mass will most likely be in their own coordinate system.
- Choosing a positive and negative direction can be tricky in these problems. The whole system will move together so choose the direction you think the system will move in, and call that direction positive. (i.e, the system above looks like it will move in a clockwise direction, so anything that is in that direction is positive)



Find the mass of M_1 in the above system. M_2 = 25kg, μ= 0.3 and the system is accelerating at 2.0 m/s clockwise.

Tension and forces at an angle

Example: The incline plane is at an angle of 30° and m_1=10kg and m_2=7kg.



a) Find the acceleration of the system with no friction.

M_1 Perpendicular ($a=0$)
$F_N - F_{g_\perp} = m_1 a$
$F_N = F_{g_\perp}$

Parallel
$F_T - F_{g_\parallel} = ma$
$F_T - m_1 g \sin 30 = m_1 a$
$F_T - (10)(9.8)\sin 30 = 10a$

M_1 Perpendicular ($a=0$)

$F_N - F_{g\perp} = m_1 a$

$F_N = F_{g\perp}$

$= m_1 g \cos 30$

$= (10)(9.8)\cos 30$

$F_N = 85\ N$

Parallel

$F_T - F_{g\parallel} = ma$

$F_T - m_1 g \sin 30 = m_1 a$

$F_T - (10)(9.8)\sin 30 = 10a$

$\boxed{F_T - 49 = 10a}$ $E_{\Sigma 1}$

M_2 Vertical

$F_g - F_T = m_2 a$

$m_2 g - F_T = m_2 a$

$(7)(9.8) - F_T = 7a$

$\boxed{68.6 - F_T = 7a}$ $E_{\Sigma 2}$

Add $E_{\Sigma 1}$ and $E_{\Sigma 2}$

$F_T - 49 = 10a$

$+ \quad 68.6 - F_T = 7a$

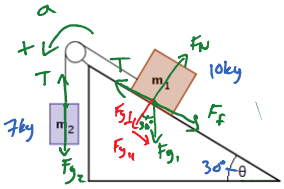
$-49 + 68.6 = 10a + 7a$

$\frac{19.6}{17} = \frac{17a}{17}$

$\boxed{1.15\ m/s^2 = a}$

Counter Clockwise

a) Find the acceleration of the system. If the frictional coeffiecent $\mu = 0.3$.



m_1

$F_{g\perp} = F_g \cos 30$

$F_{g\parallel} = F_g \sin 30$

Perpindicular ($a=0$)

$F_{Net} = ma_\perp$

$F_N - F_{g\perp} = m_1 a$

$F_N = F_{g\perp}$

$F_N = F_{g_1} \cos 30$

$= m_1 g \cos 30$

Parallel

$F_{Net} = ma$

$T - F_f - F_{g\parallel} = ma$

$\boxed{T - \mu F_N - F_{g_1} \sin 30 = m_1 a}$ $E_{\Sigma 1}$

m_2

Vertical

$\boxed{F_{g_2} - T = m_2 a}$ $E_{\Sigma 2}$

$E_{\Sigma 1} + E_{\Sigma 2}$

$T - \mu F_N - F_{g_1} \sin 30 = m_1 a$

$+ \quad F_{g_2} - T = m_2 a$

$-T - \mu F_N - F_{g_1} \sin 30 + F_{g_2} - T = m_1 a + m_2 a$

$F_{g_2} - \mu F_N - F_g \sin 30 = (m_1 + m_2) a$

$\frac{F_{g_2} - \mu F_N - F_g \sin 30}{m_1 + m_2} = \frac{(m_1 + m_2) a}{m_1 + m_2}$

$\frac{F_{g_2} - \mu F_N - F_g \sin 30}{m_1 + m_2} = a$

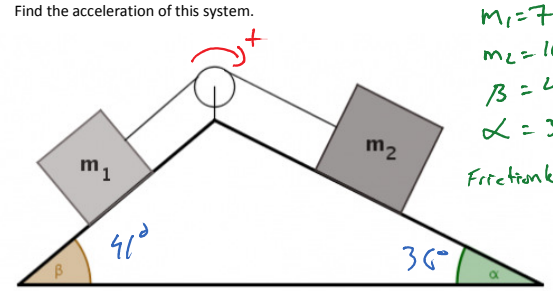
$\frac{(7)(9.8) - (0.3)(10)(9.8)\cos 30 - (10)(9.8)\sin 30}{7 + 10} = a$

$-0.345\ m/s^2 = a$

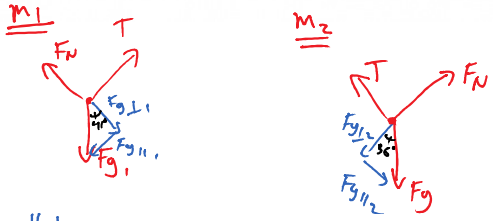
Friction can not cause the System to reverse direction of motion. Therefore a negative acceleration means the System has zero acceleration.

$\boxed{a = 0\ m/s^2}$

Find the acceleration of this system.



$m_1 = 7\,kg$
$m_2 = 10\,kg$
$\beta = 41°$
$\alpha = 36°$
Frictionless



Parallel m_1

$F_{Net} = m_1 a$

$T - F_{g_{11_1}} = m_1 a$

Parallel

$F_{Net} = m_2 a$

$F_{g_{11_2}} - T = m_2 a$

add

$T - F_{g_{11_1}} + F_{g_{11_2}} - T = m_1 a + m_2 a$

$F_{g_{11_2}} - F_{g_{11}} = (m_1 + m_2) a$

$\frac{F_{g_2} \sin 36 - F_{g_1} \sin 41}{m_1 + m_2} = a$

$\frac{(10)(9.8)\sin 36 - (7)(9.8)\sin 41}{10 + 7} = a$

$0.741\ m/s^2 = a$

Clockwise

if you want to add in friction

$-F_{f_1}$
$-F_{f_2}$
to the top

$\frac{F_{g_2} \sin 36 - F_{g_1} \sin 41 - F_{f_1} - F_{f_2}}{m_1 + m_2} = a$ added