STAEDTLER® No. 937 811E Engineer's Computation Pad

•••66 Figure 5-58 shows a box of mass $m_2 = 1.0$ kg on a frictionless plane inclined at angle $\theta = 30°$. It is connected by a cord of negligible mass to a box of mass $m_1 = 3.0$ kg on a horizontal frictionless surface. The pulley is frictionless and massless. (a) If the magnitude of horizontal force $\vec{F}$ is 2.3 N, what is the tension in the connecting cord? (b) What is the largest value the magnitude of $\vec{F}$ may have without the cord becoming slack?

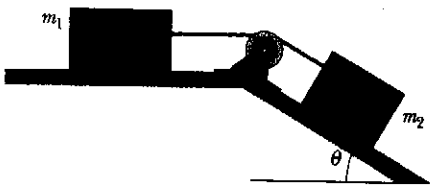


FIG. 5-58 Problem 66.

Eq^n of Motion for m_1

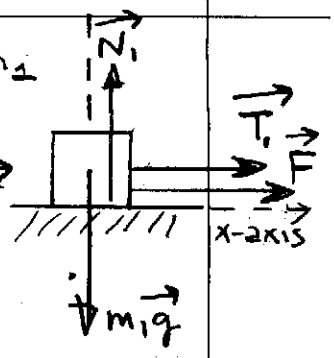
$\vec{F}_{net\ on\ m_1} = m_1\vec{a}_1$

$\vec{F}_{net} = m_1\vec{g} + \vec{N}_1 + \vec{T} + \vec{F}$

$F_{net_y} = m_1 a_{1y}$

$N_1 - m_1 g = m_1 0$

$\Rightarrow N_1 = m_1 g$



$F_{net_x} = m_1 a_{1x} \Rightarrow T + F = m_1 a_{1x} \Rightarrow a_{1x} = \frac{T+F}{m_1}$

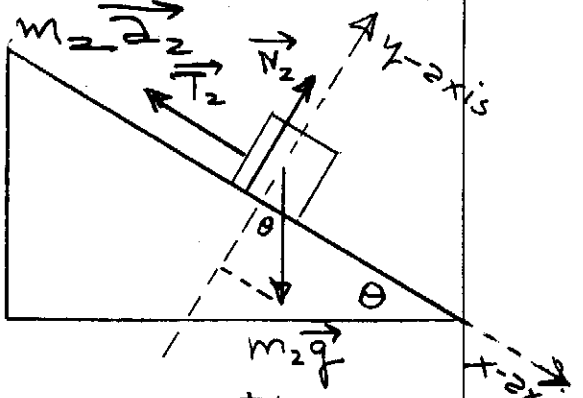
Eq^n of Motion for m_2: $\vec{F}_{net\ on\ m_2} = m_2\vec{a}_2$

$\vec{F}_{net_{on\ 2}} = m_2\vec{g} + \vec{N}_2 + \vec{T}$

$F_{net\ on\ 2\ y} = m_2 a_{2y} = m_2 0 = 0$

$F_y^{net,2} = N_2 - m_2 g\cos\theta \Rightarrow N_2 = m_2 g\cos\theta$

$F_x^{net,2} = m_2 a_{2x}$ & $F_x^{net\,2} = m_2 g\sin\theta - T$



$\Rightarrow m_2 g\sin\theta - T = m_2 a_{2x}$: to this add $F_x^{net\,1} = m_1 a_{1x}$

$+ \quad F + T = m_1 a_{1x}$: NOTE $a_{1x} \equiv a_{2x} = a$

$F + m_2 g\sin\theta = (m_1 + m_2)a \Rightarrow a = (F + m_2 g\sin\theta)/(m_1 + m_2)$

$F_x^{net,1} = m_1 a_{1x} \Rightarrow T = m_1 a - F = \left(\frac{m_1}{m_1+m_2}\right)(F + m_2 g\sin\theta) - F$

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

$T \equiv 0$ & CORD BECOMES SLACK WHEN $F = \left(\frac{m_1+m_2}{m_2}\right)\left(\frac{m_1 m_2}{m_1+m_2}\right)g\sin\theta$

$F = m_1 g\sin\theta$ (makes sence!)

ANOTHER WAY (TO JUST FIND a) $\vec{F}^{net}_{on\ system} = M_{of\ system}\vec{a}_{of\ system}$

$\vec{F}^{net}_{on\ system} = \vec{F} + \vec{T} + (-\vec{T}) + \vec{N}_1 + m_1\vec{g} + \vec{N}_2 +$

$+[m_2\vec{g} = m_2 g\cos\theta(-\hat{N}_2) + m_2 g\sin\theta\ \hat{f}_{forward}]$

$= \vec{F} + m_2 g\sin\theta\,\hat{f} = (F + m_2 g\sin\theta)\hat{f}$

$= (m_1 + m_2)a$

$\Rightarrow \vec{a} = \left(\frac{F + m_2 g\sin\theta}{m_1+m_2}\right)\hat{f}$