D:(30 pts) Incline Masses and Pulley

A block with mass $m_1 = 90kg$ sits on a rough incline with angle $\theta = 20°$. It is connected by a string over a pulley to a hanging mass. The incline surface has coefficient of static friction $\mu_S = 0.4$ and coefficient of kinetic friction $\mu_K = 0.35$. What is the maximum value of the hanging mass m_2 that will keep the system in equilibrium?

•(15*pts*) $m_{2,max} =$ 64.6 kg

Static limit: $a=0$, $f = f_{s,max}$

$f = \mu_s N = \mu_s m_1 g \cos\theta$

(I)+(II) $\Rightarrow$ $m_2 g - m_1 g \sin\theta - f =$ (III)

$m_2 g = m_1 g \sin\theta + \mu_s m_1 g \cos\theta$

$m_2 = m_1 (\sin\theta + \mu_s \cos\theta)$

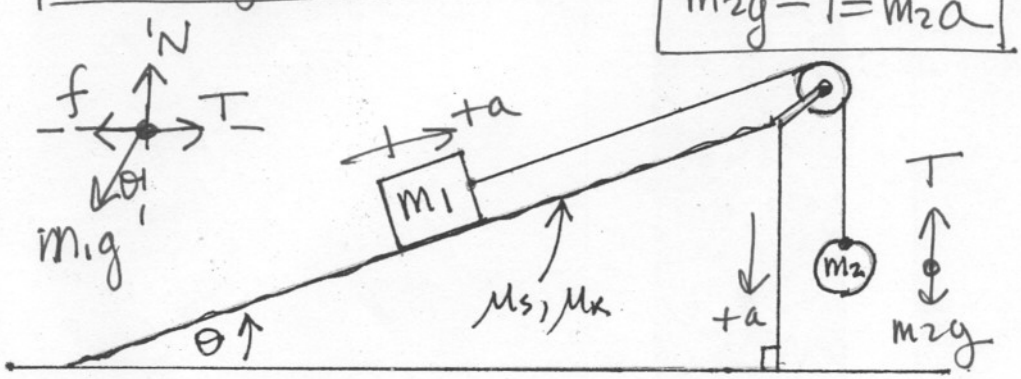
$= 64.6107$ kg

$\simeq$ **64.6 kg**

(I) $T - m_1 g \sin\theta - f = m_1 a$

$N = m_1 g \cos\theta$

(II) $m_2 g - T = m_2 a$



If instead, the value of the hanging mass is $m_2 = 80kg$, this is too much and the block moves up the incline. What is the value of the acceleration a?

•(15*pts*) $a =$ 1.13 m/s^2

$a \neq 0$, $f = f_k = \mu_k N = \mu_k m_1 g \cos\theta$

(I)+(II) $\Rightarrow$ $m_2 g - m_1 g \sin\theta - \mu_k m_1 g \cos\theta = m_1 a + m_2 a$

$g[m_2 - m_1(\sin\theta + \mu_k \cos\theta)] = (m_1 + m_2) a$

$a = g \cdot \dfrac{m_2 - m_1(\sin\theta + \mu_k \cos\theta)}{m_1 + m_2} = 1.13091$ m/s^2

$\simeq$ **1.13 m/s^2**