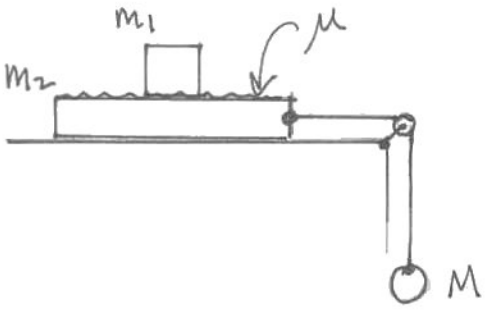
D:(30 pts) Tabletop Block and Slab

A block (mass $m_1 = 0.5kg$) sits on a rough slab (mass $m_2 = 20kg$), which sits on a frictionless table. The coefficient of static friction between the block and the slab is $\mu_s = 0.4$. The coefficient of kinetic friction between the block and the slab is $\mu_\kappa = 0.35$. A hanging weight (mass M) is connected by a string over a pulley to the slab; the masses are then all released from rest. What is the biggest weight (mass M_{max}) that can be used, so that the block and slab stay together (i.e., not sliding against each other)? If this weight is used, what is the acceleration a_{stick} of the block and slab?

•(12*pts*) M_{max} =_____

•(12*pts*) a_{stick} =_____



If a weight with mass $M = 15kg$ is used, this is too heavy and the block cannot keep up with the slab; i.e. the block and slab slide against each other. In this case, what is the acceleration a_{slide} of the block?

•(12*pts*) a_{slide} =_____

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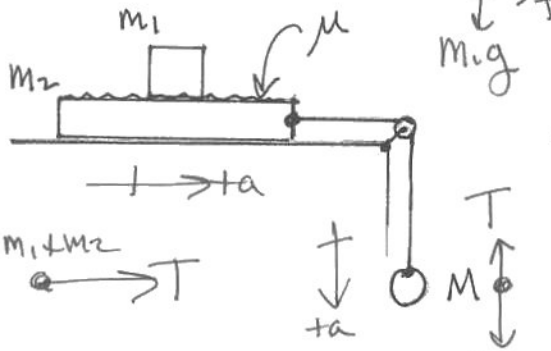
•(12pts) $M_{max} =$ 12.2 kg

•(12pts) $a_{stick} =$ $3.92\ m/s^2$



• Find a_{MAX} :

$f_{s,MAX} = \mu_s n_1 = \mu_s m_1 g$

$f_{s,MAX} = m_1 a_{MAX}$

$\Rightarrow a_{MAX} = \mu_s g = \boxed{3.92\ m/s^2}$

• Find M : $Mg - T = Ma$; $T = (m_1+m_2)a$

$\Rightarrow Mg = (M+m_1+m_2)a$

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

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

$= (m_1+m_2)\frac{\mu_s}{1-\mu_s}$

$= \frac{12.17576}{13.6667}\ kg \simeq \boxed{12.2\ kg}$

$\boxed{13.7\ kg}$

If a weight with mass $M = 15kg$ is used, this is too heavy and the block cannot keep up with the slab; i.e. the block and slab slide against each other. In this case, what is the acceleration a_{slide} of the block?

•(12pts) $a_{slide} =$ $3.43\ m/s^2$

$f_K = \mu_K n_1 = \mu_K m_1 g$

$f_K = m_1 a$

$\Rightarrow a = \mu_K g = \boxed{3.43\ m/s^2}$