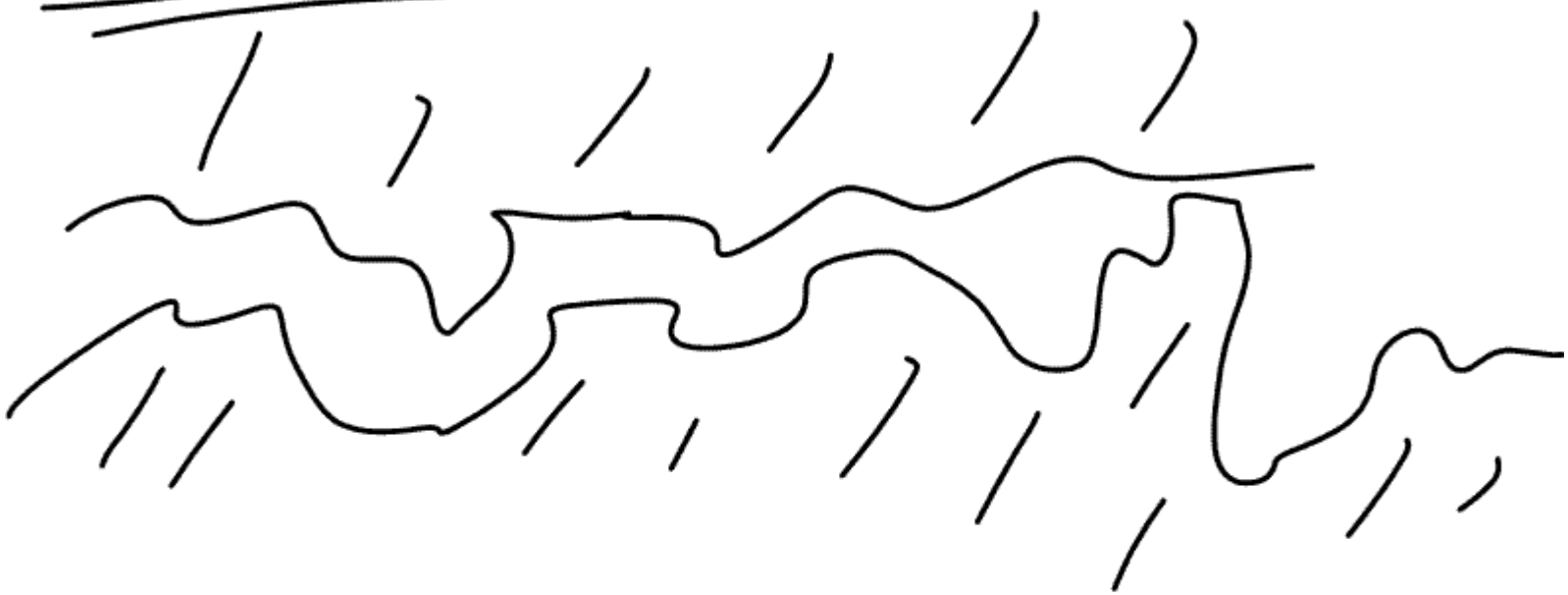
# Physics 113 - October 3, 2006

- Exam 1 - during class time slot Thursday in Hoyt
- Q+A session Wed. 5 - 6:30 B+L 106
- P.S. 4 Solns
- Formula sheet (one provided w/ exam)

Last Lecture . . .

# Friction



$$|\vec{F}_{fr}| \propto |\vec{N}|$$

$$|\vec{F}_{fr}| = \mu_k |\vec{N}|$$

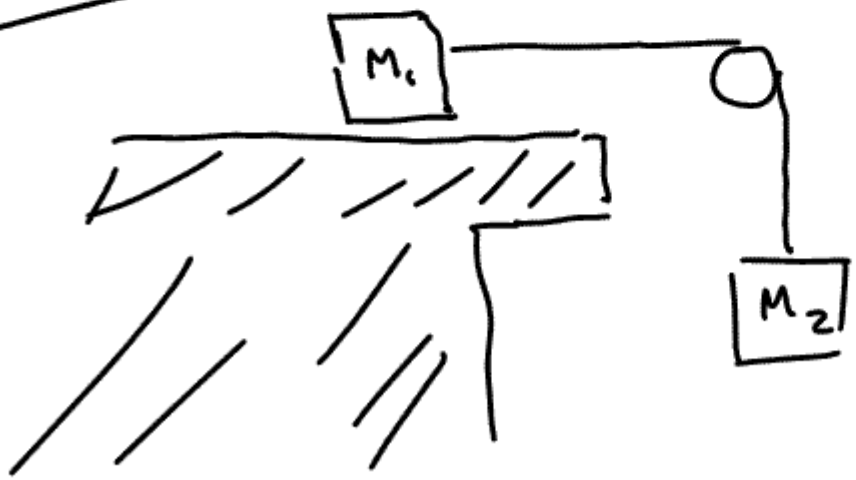
$\mu_k$: Coeffic. of kinetic friction → motion

$$|\vec{F}_{fr}| \leq \mu_s |\vec{N}|$$

$\mu_s$: Coeffic. of STATIC friction

limiting value of STATIC frictional force (largest)

Example



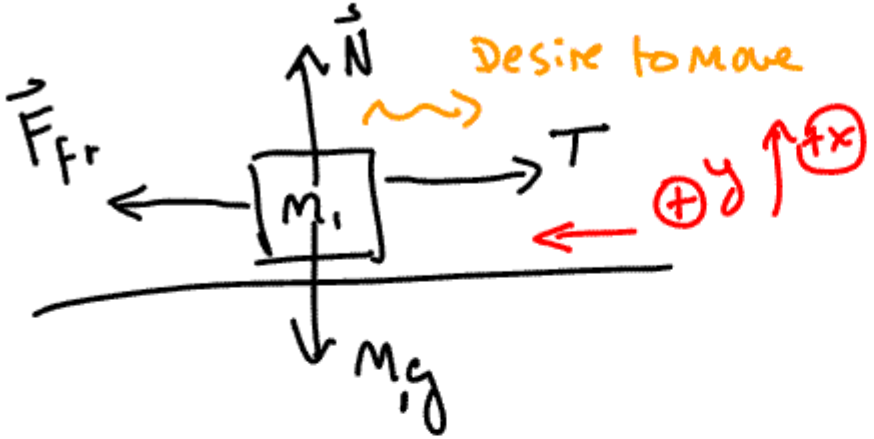

System starts at rest in equilibrium

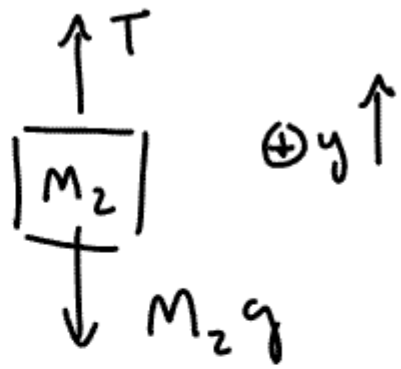
$M_2 = 20\ kg$

$M_1 = 10\ kg$

What is smallest $\mu_s$

(bet. table and $M_1$) that can lead to this condition?




$$\Sigma \vec{F}_{m_1} = m_1 \vec{a}_1$$

$$\Sigma \vec{F}_{m_2} = m_2 \vec{a}_2$$

x eqn

$$\Sigma F_x = m_1 a_{1,x} = 0$$

$$0 = N - m_1 g$$

$$N = m_1 g$$

y //

$$\Sigma F_y = T - m_2 g = m_2 a$$

$$\Sigma F_y = m_1 a_y = m_1 a$$

$$m_1 a = F_{Fr} - T$$

$$F_{Fr} = \mu_s N$$

$N = (10)(9.8) = 98$ Newtons

$m_1 a = \mu_s N - T$

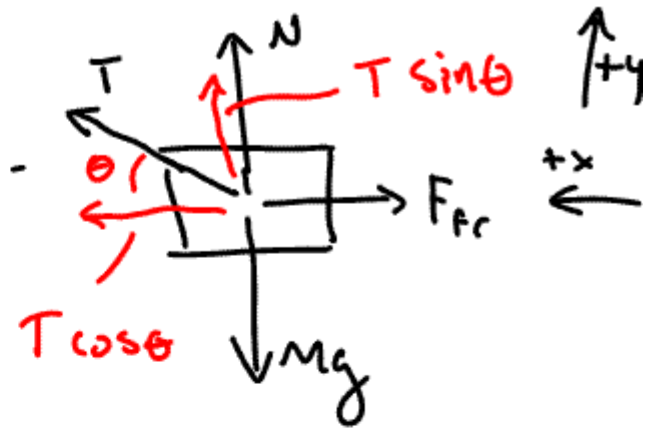
$m_1 a = \mu_s m_1 g - T$

$T = m_2 a + m_2 g$

$m_1 a = \mu_s m_1 g - m_2 a - m_2 g$

$a = 0$

$$\mu_s = \frac{m_2}{m_1}$$


$$\Sigma F_y = 0 = N + T\sin\theta - Mg$$

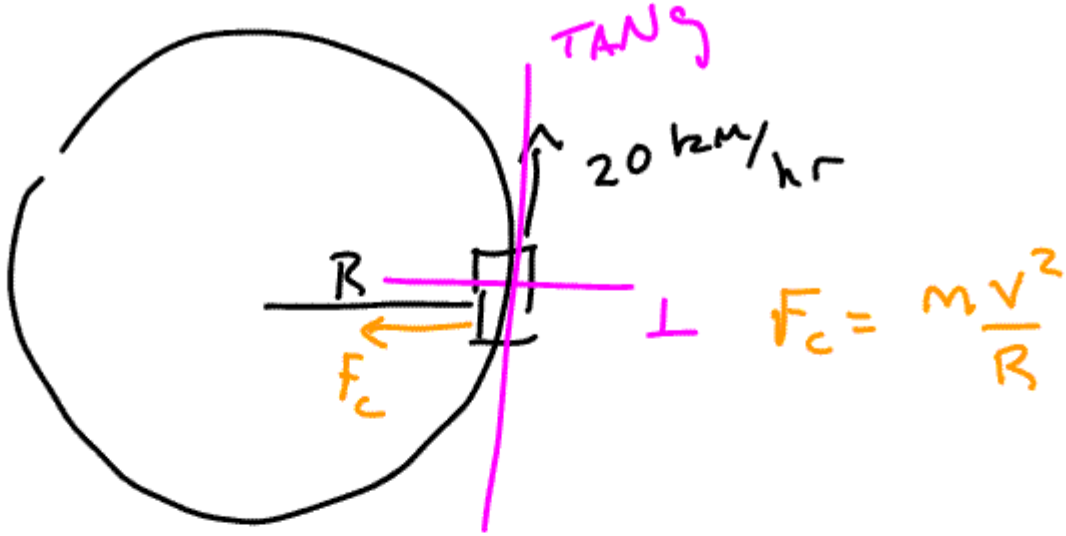
$$N = Mg - T\sin\theta$$

$$F_{fr} = \mu_k N = \mu_k (Mg - T\sin\theta)$$

$$\Sigma F_x = Ma = T\cos\theta - F_{fr}$$

$$F_{fr} = T\cos\theta - Ma$$

Example

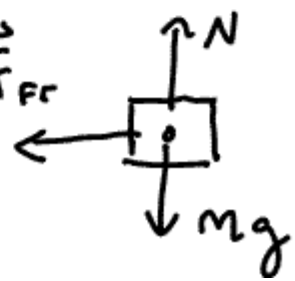



Car driven in circle Radius R (50 m)
Moves at speed of 20 km/hr

What is minimum coefficient of static friction $\mu_s$ required to keep the car on road?

$20\ ^{km}/_{hr} \rightarrow 5.5\ ^{M}/_{s}$

$\vec{F}_c = \vec{F}_{Fr}$



$$\Sigma F_{TANG} = 0$$

$$\Sigma F_y = 0 = N - Mg \Rightarrow N = Mg$$

$$\Sigma F_{radial} = \frac{mv^2}{R} = F_{Fr} = \mu_s N = \mu_s Mg$$

$$\frac{\cancel{M} v^2}{R} = \mu_s \cancel{M} g \quad \Big| \quad \boxed{\mu_s = \frac{v^2}{Rg}}$$