Physics 271, Section ... Thursday, Oct 2, 2014
Quiz #4 Force & Motion [II]

Name: [5 pts]

1) Consider a small box with mass $m = 1.0$ kg and a big box with mass $M = 5$kg. We put the small box on the side of the big box and press with the force F, see fig. 1. The coefficients of static friction between the two boxes is $\mu_s = 0.5$, and the friction between the big box and the ground is negligible.

a) Draw the separate free body diagrams for the boxes. **[2 pts]**
b) Write down the equations of motion for each box. **[4 pts]**
c) What is the static friction force on the small box, if we know that the box is not sliding? **[1 pt]**
d) Find the normal force between the boxes as a function of F. **[2 pts]**
e) Find the condition on F so that the small box does no slide relative to the big box. **[2 pts]**

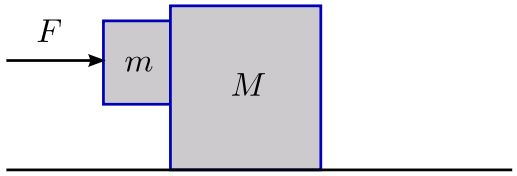
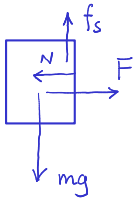
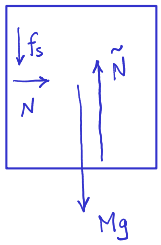


Figure 1: The mass m is not slipping down.

a)





N : normal force between small box & big box
$\tilde{N}$: " " " ground & big box
f_s : static friction force

b)

$$\begin{cases} F - N = ma & \text{(i)} \\ mg - f_s = 0 \end{cases}$$

assuming the small box is not slipping

$$\begin{cases} N = Ma & \text{(ii)} \\ \tilde{N} - mg - f_s = 0 \end{cases}$$

c) $f_s = mg$.

d) (i) + (ii) $\rightarrow$ $F = (m+M)a \rightarrow a = \dfrac{F}{m+M}$. Using either (i) or (ii) : $N = \dfrac{M}{m+M} F$.

e) $f_s < \mu_s N \rightarrow mg < \mu_s N = \mu_s \dfrac{M}{m+M} F$

$$\rightarrow F > \frac{m(m+M)}{M\mu_s} g .$$