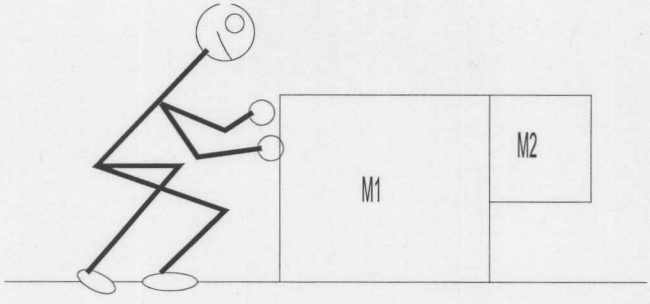
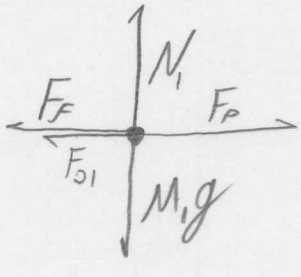
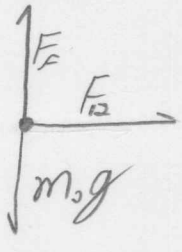
Force Problems

Stick man is pushing a stack of rough blocks on a rough floor. Being a careless sort of fellow, he tips the stack over. As the blocks fall, Stick Man quickly pushes on M1 to keep M2 from hitting the floor. In terms of M1, M2, g, μ_k and μ_s, what is the force that Stick Man must push with to keep M2 from hitting the floor.



a) Draw a free body diagram for each mass. Thing carefully about the forces involved.
b) Write Newton's second law for each free body diagram. You will have 4 equations, one per axis for each mass. Think carefully about what the condition is for M2 to not slip.
c) Solve the system of equations for the force of Stick man's push





$x: F_P - \mu_k N - F_{21} = M_1 a_x$

$y: N - M_1 g = 0$

$F_P - \mu_k M_1 g - m_2 a_x = M_1 a_x$

$F_P - \mu_k M_1 g = (M_1 + m_2) a_x$

$x: F_{12} = m_2 a_x$

$y: \mu_s F_{12} - m_2 g = 0$

$\mu_s m_2 a_x = m_2 g$

$m_2 g = \mu_s m_2 a_x$

continued ↓

Divide

$$\frac{F_p - \mu_k M_1 g}{M_2 g} = \frac{(M_1 + M_2)\alpha_x}{\mu_s M_2 \alpha_x}$$

$$F_p = \frac{g}{\mu_s}(M_1 + M_2) + \mu_k M_1 g$$

$$= \frac{g}{\mu_s} M_1 + \frac{g}{\mu_s} M_2 + \mu_k g M_1$$

$$\boxed{F_p = g\left(\frac{M_1 + M_2}{\mu_s} + \mu_k M_1\right)}$$