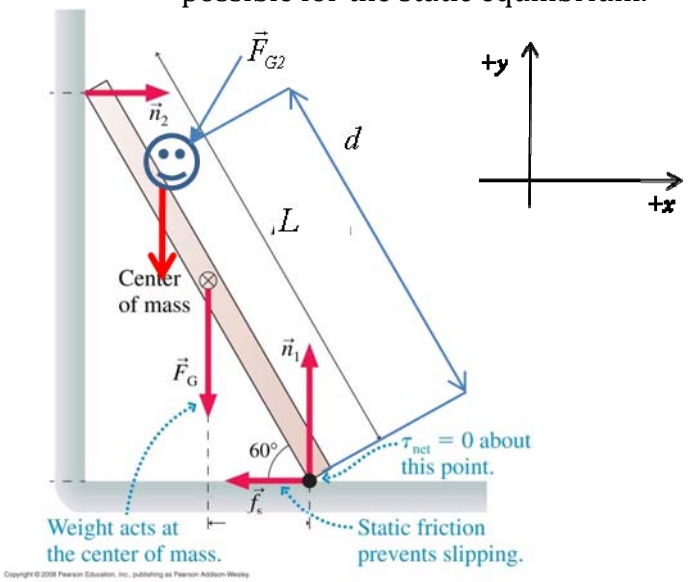
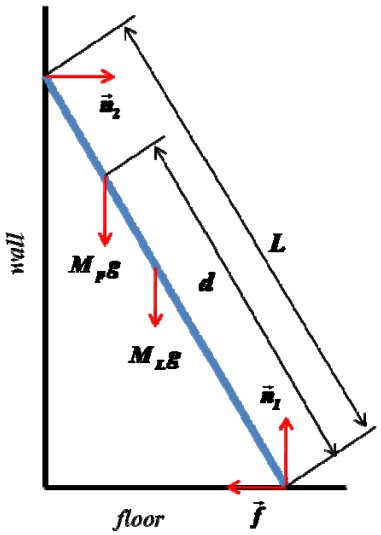
Physics 2211K, 11/4/2010
Quiz # 10 Solution

In the situation sketched below, the ***length of the ladder L = 6 m***, and the ***person is up it the distance d = 4 m***. Also, the mass of the ladder is $m_L = 25$ ***kg*** and that of the person is $m_P = 90$ ***kg***. The ***wall is frictionless*** but there is friction f_s between the ladder and the floor.

a. The system is in static equilibrium. Use a force and torque analysis to calculate all the forces acting on the ladder: n_1, n_2, *and* f_s

b. From the results in ***part a.***, calculate the minimum coefficient of static friction μ_s possible for the static equilibrium.





Analysis:

Forces $(g = 10\ m/s^2)$

$x:\ 0 = n_2 - f_s \Rightarrow \boxed{n_2 = f_s}$

$y:\ 0 = n_1 - M_L g - M_p g \Rightarrow \boxed{n_1 = M_L g + M_p g = 1150\ N}$

Torques ***(CR @ contact with floor)***

$\tau_{cw} = \tau_{ccw}$

$$L(n_2 \sin\theta) = d\left(M_p g\cos\theta\ \right) + \frac{L}{2}\left(M_L g\cos\theta\right) = L\left(f_s \sin\theta\right)$$

$$\boxed{f_s = \frac{\left(dM_p + \frac{L}{2}M_L\right)g\cos\theta}{L\sin\theta} = 418.7\ N\ = n_2}$$

$$\boxed{\mu_{s,min} = \frac{f_s}{n_1} = \frac{418.7\ N}{1150\ N} = 0.364}$$