53. When it is about to move, we are still able to apply the equilibrium conditions, but (to obtain the critical condition) we set static friction equal to its maximum value and picture the normal force $\vec{N}$ as a concentrated force (upward) at the bottom corner of the cube, directly below the point $\mathcal{O}$ where P is being applied. Thus, the line of action of $\vec{N}$ passes through point $\mathcal{O}$ and exerts no torque about $\mathcal{O}$ (of course, a similar observation applied to the pull P). Since $N = mg$ in this problem, we have $f_{s\max} = \mu mg$ applied a distance h away from $\mathcal{O}$. And the line of action of force of gravity (of magnitude mg), which is best pictured as a concentrated force at the center of the cube, is a distance $L/2$ away from $\mathcal{O}$. Therefore, equilibrium of torques about $\mathcal{O}$ produces

$$\mu mgh = mg\left(\frac{L}{2}\right) \implies \mu = \frac{L}{2h}$$

for the critical condition we have been considering. We now interpret this in terms of a range of values for μ.

(a) For it to slide but not tip, a value of μ *less* than that derived above is needed, since then – static friction will be exceeded for a smaller value of P, before the pull is strong enough to cause it to tip. Thus, $\mu < L/2h$ is required.

(b) And for it to tip but not slide, we need μ *greater* than that derived above is needed, since now – static friction will not be exceeded even for the value of P which makes the cube rotate about its front lower corner. That is, we need to have $\mu > L/2h$ in this case.