C:(30 points) Chute and Slide

A box with mass m slides down a frictionless chute from a height $H = 0.4m$. It then collides with an identical box sitting at rest on level ground. The boxes stick together and proceed to slide over rough horizontal ground for a distance $L = 0.6m$ before they stop. What is μ_κ, the coefficient of kinetic friction between the boxes and the ground?

•(15*pts*) $\mu_\kappa =$ 0.167

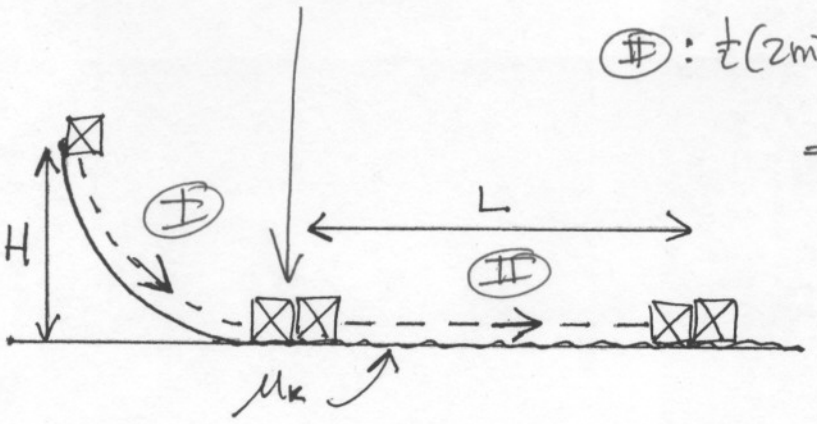
Ⅰ: $mgH = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gH} = 2.8\,\frac{m}{s}$

Collision: $mv = (m+m)v' \Rightarrow v' = v/2 = 1.4\,m/s$

Ⅱ: $\frac{1}{2}(2m)v'^2 = f_k L = \mu_k (2m) g L$

$\Rightarrow \mu_k = \frac{v'^2}{2gL} = \frac{v^2}{8gL}$

$= \frac{H}{4L} = \frac{1}{6} \simeq \boxed{.167}$



Suppose that, instead of sticking together, the boxes undergo an elastic collision. What distance L' would the box on the right slide in this case?

•(15*pts*) $L' =$ 2.4m

Find new v': $v_1 = 2.4\,m/s$, $v_2 = 0$, $m_1 = m_2 = m$

$v' \sim v_2' = \frac{2m_1}{m_1+m_2} v_1 + \frac{m_2 - m_1}{m_1+m_2} v_2 = v_1$

$= \sqrt{2gH} = 2.8\,m/s$.

Ⅱ: $\frac{1}{2}m v_2'^2 = \mu_k m g L' \Rightarrow$

$L' = \frac{v_2'^2}{2\mu_k g} = \frac{H}{\mu_k} = \boxed{2.4m}$.