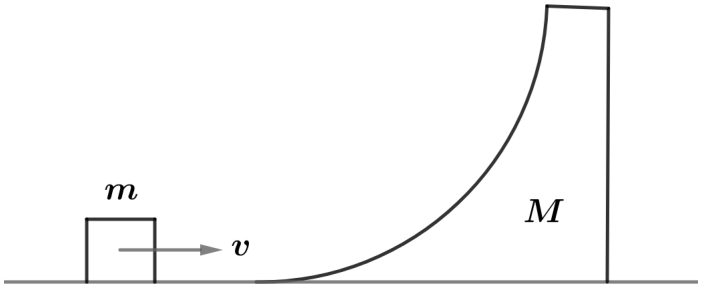
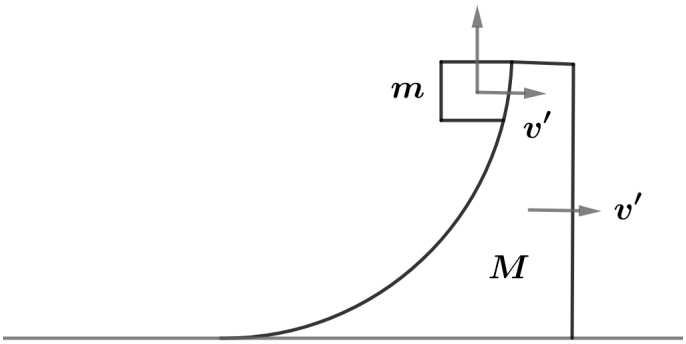
2019A F=ma Exam: Problem 3

Kevin S. Huang

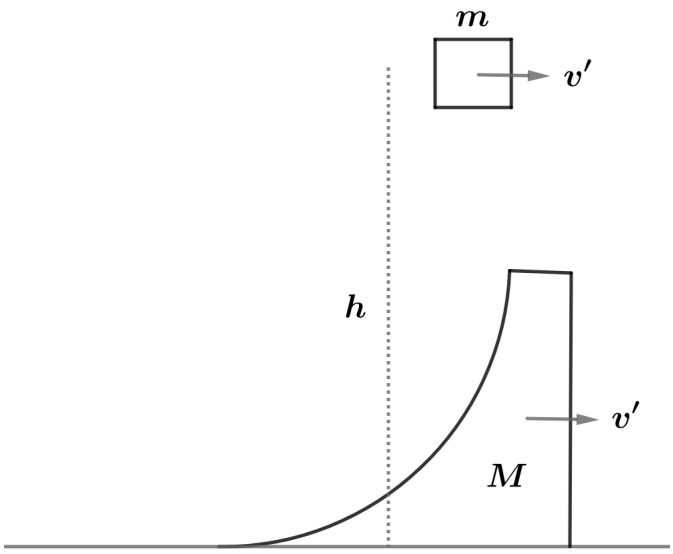


We have the initial momentum and energy of the system:

$$p_i = mv$$
$$E_i = \frac{1}{2}mv^2$$



Note that when the block leaves the wedge they have the same velocity in the horizontal direction since they were in contact.



The final momentum and energy of the system is

$$p_f = mv' + Mv'$$
$$E_f = mgh + \frac{1}{2}mv'^2 + \frac{1}{2}Mv'^2$$

Conserving momentum and energy,

$$mv = mv' + Mv'$$
$$\frac{1}{2}mv^2 = mgh + \frac{1}{2}mv'^2 + \frac{1}{2}Mv'^2$$

so

$$v' = \frac{mv}{m+M}$$

Simplifying,

$$\frac{1}{2}mv^2 = mgh + \frac{1}{2}(m+M)\left(\frac{m}{m+M}\right)^2 v^2$$
$$mgh = \frac{1}{2}mv^2\left(1 - \frac{m}{m+M}\right)$$
$$h = \frac{M}{m+M}\frac{v^2}{2g}$$

so the answer is $\boxed{\text{E}}$.