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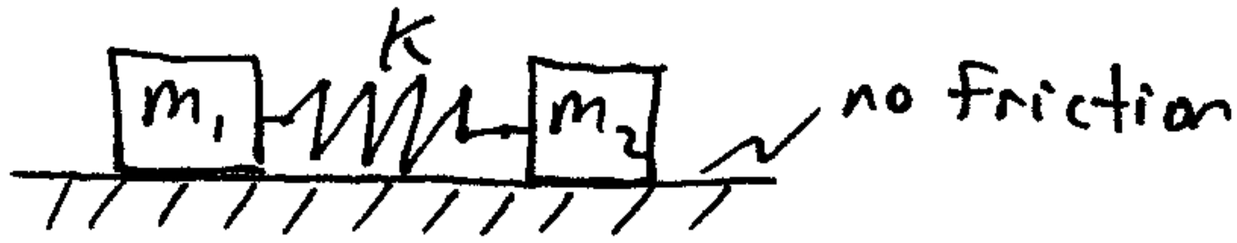
Nov. 9, 2020

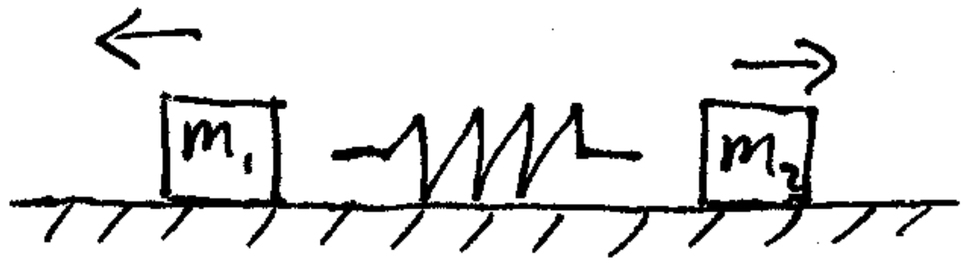
This is a problem involving systems of particles.



Two masses, m_1 and m_2, are pushed against a spring of stiffness K. The spring is initially compressed by an amount ΔL, and then the masses are simultaneously released. What is the final velocity of the two masses?

<u>Solution:</u>

Energy and linear momentum are both conserved.



$\rightarrow +$

Conservation of linear momentum:

$v_{1i} = v_{2i} = 0$ (zero initial velocity)

$m_1 v_{1i} + m_2 v_{2i} = -m_1 v_{1f} + m_2 v_{2f}$

$\Rightarrow \quad 0 = -m_1 v_{1f} + m_2 v_{2f} \qquad (1)$

$\sum F = 0$ in the system, in horizontal direction, so linear momentum is conserved

Conservation of energy:

$$\frac{1}{2} K (\Delta L)^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2 \qquad (2)$$

From equation (1), $v_{2f} = \frac{m_1}{m_2} v_{1f}$

substitute this into equation (2):

$$\Rightarrow \frac{1}{2} k (\Delta L)^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 \cdot \frac{m_1^2 v_{1f}^2}{m_2^2}$$

Solve: $\Rightarrow v_{1f} = \sqrt{\frac{k(\Delta L)^2}{m_1 + \frac{m_1^2}{m_2}}}$ (answer)

and

$$\Rightarrow v_{2f} = \sqrt{\frac{k(\Delta L)^2}{m_2 + \frac{m_2^2}{m_1}}}$$ (answer)