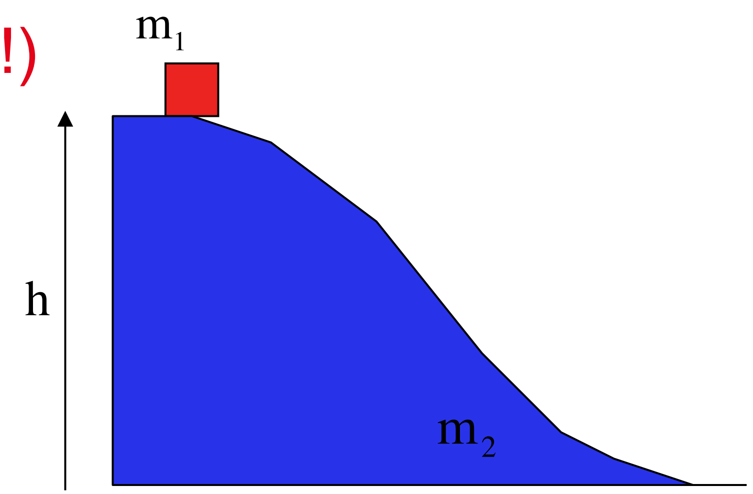
Problem 6.65 (another great problem!)



A small, .5 kg block starts from rest and slides down a frictionless, curved incline of mass 3 kg. When the block leaves the incline, it is moving with velocity 4 m/s.

a.) What's the velocity of the wedge when the block reaches the ground?

b.) What's the height of the wedge?

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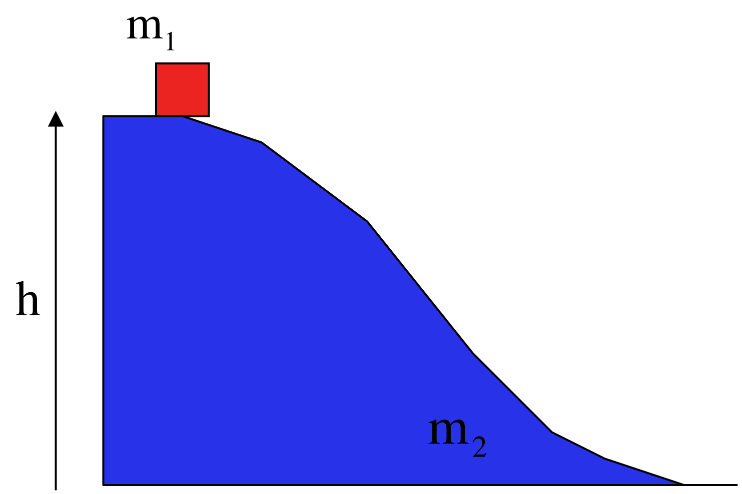


a.) What's the velocity of the wedge when the block reaches the ground?

The wedge's momentum changes in the x direction due to the impulse provided by the block, and the block's momentum changes in the x-direction due to the impulse provided by the wedge. Both impulses are *internal*, so momentum is conserved *in the x-direction* (but not in the *y-direction*). Written out, this becomes:

$$\sum p_{1,x} + \sum F_{ext}\Delta t = \sum p_{2,x}$$

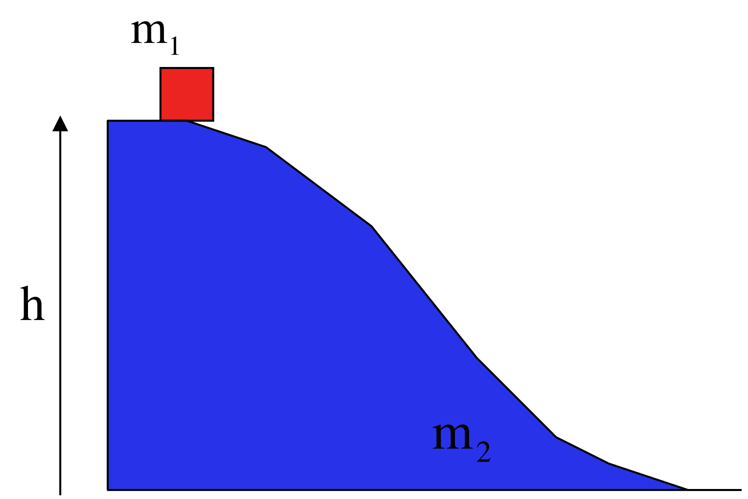
$$0 + 0 = m_1 v_1 - m_2 v_2$$

$$\Rightarrow \quad v_2 = \frac{m_1 v_1}{m_2}$$

$$\Rightarrow \quad v_2 = \frac{(.5\ \text{kg})(4\ \text{m/s})}{(3\ \text{kg})}$$

$$\Rightarrow \quad v_2 = .67\ \text{m/s}$$

b.) What's the height of the wedge?



This is a straight up conservation of energy problem. Using that approach yields:

$$\sum KE_1 + \sum U_1 + \sum W_{extraneous} = \sum KE_2 + \sum U_2$$

$$\Rightarrow \quad 0 \quad + m_1gh \; + \quad 0 \quad = \left(\frac{1}{2}m_1v_1^{\;2} + \frac{1}{2}m_2v_2^{\;2}\right) + 0$$

$$\Rightarrow \quad h = \left(\frac{\left(\frac{1}{2}m_1v_1^{\;2} + \frac{1}{2}m_2v_2^{\;2}\right)}{m_1g}\right)$$

$$\Rightarrow \quad h = \left(\frac{\left(\frac{1}{2}(.5 \text{ kg})(4 \text{ m/s})^2 + \frac{1}{2}(3 \text{ kg})(.67 \text{ m/s})^2\right)}{(.5 \text{ kg})(9.8 \text{ m/s}^2)}\right)$$

$$\Rightarrow \quad h = .95 \text{ m}$$