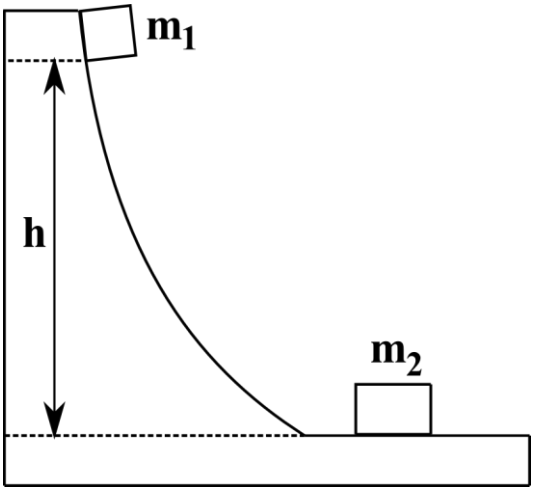
Answer on Question 59896, Physics, Other

Question:

Two blocks are free to slide along the frictionless wooden track. The block of mass $m_1 = 5\ kg$ is released from the position shown, at height $h = 5\ m$ above the flat part of the track. Protruding from its front end is the north pole of a strong magnet, which repels the north pole of an identical magnet embedded in the back end of the block of mass $m_2 = 10\ kg$, initially at rest. The two blocks never touch. Calculate the maximum height to which m_1 rises after the elastic collision.

Solution:

Here's the sketch of our task:



Let's first find the velocity of the first block just before the collision from the Law of Conservation of Energy:

$$KE = PE,$$

$$\frac{1}{2}m_1 v_{1i}^2 = m_1 gh,$$

$$v_{1i} = \sqrt{2gh} = \sqrt{2 \cdot 9.8\ \frac{m}{s^2} \cdot 5\ m} = 9.9\ \frac{m}{s}.$$

Then, from the Law of Conservation of Momentum we can find the final velocities of two blocks after the collision (since the second block initially at rest, $v_{2i} = 0\ ms^{-1}$):

$$m_1 v_{1i} + 0 = m_1 v_{1f} + m_2 v_{2f},$$

here, m_1, m_2 are the masses of two blocks, v_{1i} is the velocity of the first block just before the collision; v_{1f}, v_{2f} are the velocities of each block after the collision.

Since the collision is elastic, kinetic energy is conserved and we can write:

$$\frac{1}{2}m_1v_{1i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2.$$

This formula gives us an additional relationship between the velocities. Therefore, with the help of these two formulas we can find the velocity of each block after the collision:

$$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)}v_{1i} = \frac{(5.0\ kg - 10.0\ kg)}{(5.0\ kg + 10.0\ kg)}9.9\ ms^{-1} = -3.3\ ms^{-1}.$$

The sign minus indicates that the first block changes the direction of velocity after the collision and moves in the opposite direction to the left.

$$v_{2f} = \frac{2m_1v_1}{(m_1 + m_2)} = \frac{2 \cdot 5.0\ kg \cdot 9.9\ ms^{-1}}{(5.0\ kg + 10.0\ kg)} = 6.6\ ms^{-1}.$$

The sign plus indicates that the second block moves in the positive direction to the right.

Let's again applying the Law of Conservation of Energy to find the maximum height to which the first block rises after the elastic collision:

$$KE = PE,$$

$$\frac{1}{2}m_1v_{1f}^2 = m_1gh_{max},$$

$$h_{max} = \frac{v_{1f}^2}{2g} = \frac{(-3.3\ ms^{-1})^2}{2 \cdot 9.8\ \frac{m}{s^2}} = 0.556\ m.$$

Answer:

$h_{max} = 0.556\ m.$