



As we can see from the following the only physical variables that remain the same are – Energy and momentum across the x-axis . At the beginning we choose two points namely – point A and the top of the hill

$$E_i = E_f$$

$$m_1 g R = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$$p_{xi} = p_{xf}$$

$$0 = m_1 v_1 + m_2 v_2$$

By the solution of those two equations we can find the velocities of the mass and the cart

$$v_1 = \frac{2mgR}{1 + \frac{m_1}{m_2}}$$

$$v_2 = -\frac{m_1}{m_2} \frac{2mgR}{1 + \frac{m_1}{m_2}}$$

Let us find the maximum contract of the spring in this case both the masses suppose to follow the same velocity , as we may see the total momentum of the system regarding the x-axis is zero-which leads us to the following

$$0 = (m_1 + m_2)u$$

$$u = 0$$

As a result we get the following equation for energy

$$E_i = E_f$$

$$m_1 g R = \frac{1}{2} (m_1 + m_2) u^2 + \frac{1}{2} k x^2$$

Taking $u = 0$ we get $x = \sqrt{\frac{2m_1 g R}{k}}$