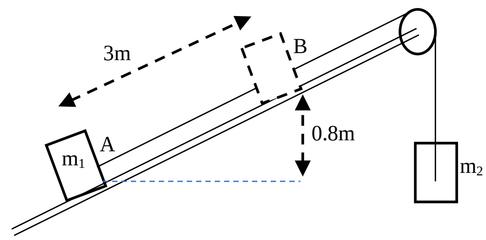
Q- Two blocks are connected by a light cord passing over a frictionless pulley. Their masses are m_1 = 3 kg and m_2 = 2 kg and the ramp is frictionless. At position A the block m_1 is sliding up at velocity 2.5 m/s. Find the speed of the block at position B.



Law of conservation of mechanical energy:

If there are no non-conservative forces acting on a system its total mechanical energy remains conserved.

Mechanical energy is the sum of kinetic and all types of potential energies (like gravitational, elastic and electrostatic). Here the potential energy of block A is increasing while that of block B is decreasing. As the blocks are attached with an inextensible string their speed will remain always equal.

Let the initial speed (at position A) of the system is v_1 (= 2.5 m/s) and the final speed (at position B) is v_2. Thus, the increase in kinetic energy of the system when block on the ramp comes from position A to position B will be

$$\Delta KE = \frac{1}{2}(m_1 + m_2)v_2^2 - \frac{1}{2}(m_1 + m_2)v_1^2$$

Or $$\Delta KE = \frac{1}{2}(m_1 + m_2)(v_2^2 - v_1^2) \qquad \text{----------------- (1)}$$

Block on the ramp is moved up by a vertical distance of h_1 (= 0.8 m) hence increase in its potential energy will be m_1gh_1 while the hanging block will come vertically down by the distance equal to that moved by the block on the ramp h_2 (= 3 m) and hence decrease in the potential energy of the hanging block will be m_2gh_2.

Hence the net loss in the potential energy of the system will be given by

$$\Delta PE = m_2\, g\, h_2 - m_1\, g\, h_1 \qquad \text{----------------- (2)}$$

As there are no non-conservative forces the total mechanical energy of the system will be conserved or the gain in kinetic energy of the system will be equal to the loss in its potential energy thus from (1) and (2) we get

$$\frac{1}{2}(m_1 + m_2)(v_2^2 - v_1^2) = m_2\, g\, h_2 - m_1\, g\, h_1$$

Or on substituting the values we get

$$\frac{1}{2}(3 + 2)(v_2^2 - 2.5^2) = 2 * 9.8 * 3 - 3 * 9.8 * 0.8$$

Or $$2.5 * (v_2^2 - 6.25) = 35.28$$

Or $$(v_2^2 - 6.25) = 14.11$$

Or $$v_2^2 = 14.11 + 6.25 = 20.36$$

Gives $v_2 = \sqrt{20.36} = 4.51\ m/s$

Hence the speed of the blocks in second position will be **4.51 m/s.**