Answer on Question #70794, Physics / Mechanics | Relativity

A 5 kg block is attached by means of a string to a 2 kg block on a 30° slope. The string is passed over a 3 kg pulley. The co-efficient of sliding friction between the 2 kg block and the slope is 0.2. Find the velocity of the hanging mass piece after the hanging mass piece has moved down 0.5 m. Solve this problem two different ways:

(a) Using energy considerations.
(b) Using Newton's Second Law of Motion.

Solution:

a) Initial energy: $M_{5kg}gH$

Final energy: $\frac{M_{5kg}v^2}{2} + m_{2kg}gh + m_{2kg}v_{3kg}^2$

According to energy conservation law: $M_{5kg}gH = \frac{M_{5kg}v^2}{2} + m_{2kg}gh + \frac{m_{2kg}v^2}{2} + A_{friction}$

Geometrically: $h = H * sin30°,\ A_{friction} = \mu m_{2kg}g * cos30° * H$

So, final speed is: $v^2(M_{5kg} + m_{2kg}) = M_{5kg}gH - m_{2kg}gHsin30° - \mu m_{2kg}gH * cos30°$

$$v = \sqrt{\frac{M_{5kg}gH - m_{2kg}gHsin30° - \mu m_{2kg}g * Hcos30°}{M_{5kg} + m_{2kg}}} = 1.6\frac{m}{s}$$

b) $F = F_{gr_{5kg}} - F_{gr_{2kg}} * sin30° - F_{friction} * cos30°$

$F = M_{5kg}g - m_{3kg}g * sin30° - \mu m_{3kg}g * cos30° = (M_{5kg} + m_{2kg})a$

$$H = \frac{v^2}{a} \rightarrow \quad v = \sqrt{aH} = \sqrt{\frac{M_{5kg}gH - m_{2kg}gHsin30° - \mu m_{2kg}g * Hcos30°}{M_{5kg} + m_{2kg}}} = 1.6\frac{m}{s}$$

Answer: Final speed is 1.6 m/s