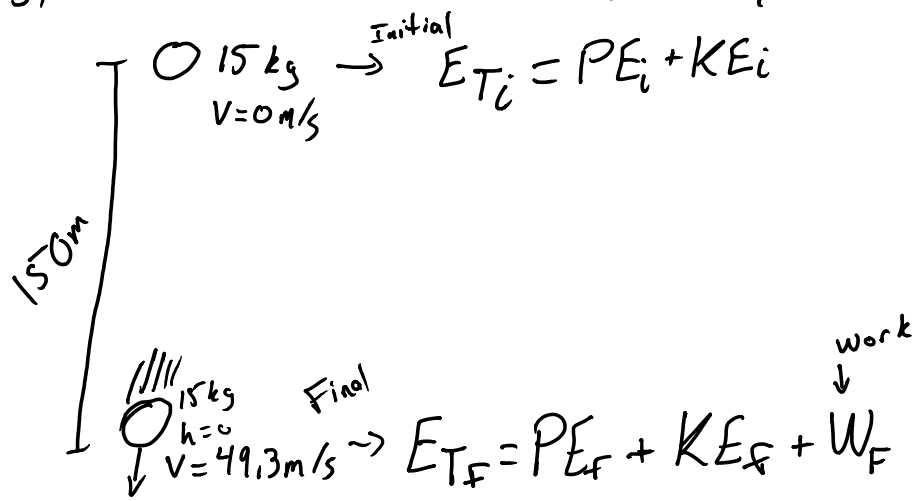
Energy Conservation with Friction & Challenge Problems

March-09-16 8:36 AM

Law of Cons. of Energy:

→ $E_{T_i} = E_{T_F}$ ← Use this all the time

(1) A 15 kg ball is dropped from 150m high. Just as it reaches the ground, the velocity is 49.3m/s. How much energy was lost to air resistance?



$PE = mgh$

$KE = \frac{1}{2}mv^2$

$PE_i + KE_i = PE_F + KE_F + W_F$

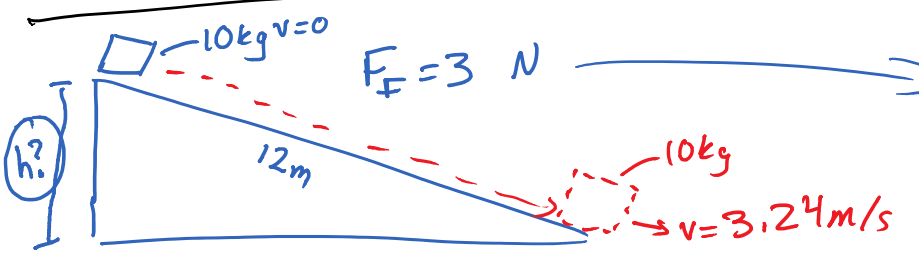
$mgh_i + \frac{1}{2}mv_i^2 = mgh_F + \frac{1}{2}mv_F^2 + W_F$

$15(9.8)(150) + 0 = 0 + \frac{1}{2}(15)(49.3)^2 + W_F$

$22050 = 18228.675 + W_F$

$3821.325 = W_F$

$W_F = 3820J$



$W = F \cdot d$

$W = 3\ N \times 12m$

$W = 36J$

$E_{T_i} = E_{T_F}$

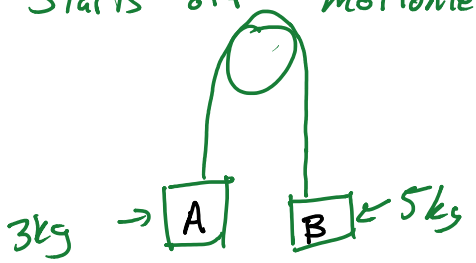
$$mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2 + W_F$$

$$10(9.8)h_i + 0 = 0 + \frac{1}{2}(10)(3.24)^2 + 36$$

$$\frac{98h_i}{98} = \frac{52.488 + 36}{98}$$

$$\boxed{h_i = 0.903\text{m}}$$

An Atwood machine is set up with a 3kg and 5kg mass. The string and pulley are massless and Frictionless. Find the velocity after the 5kg mass has dropped 30cm. Starts off motionless. The masses will have the same velocity.

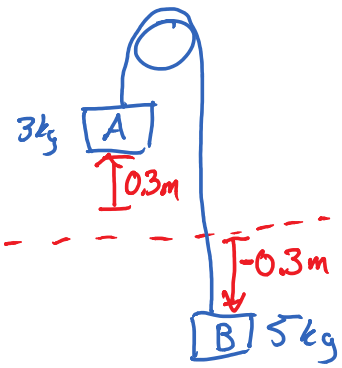


$$E_{Ti} = E_{TA} + E_{TB}$$

$$= m_A g h_A + m_B g h_B + \frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2$$

$$E_{Ti} = 0 + 0 + 0 + 0$$

$$E_{Ti} = 0$$



$$0 = E_{TF} = E_{TA} + E_{TB}$$

$$= m_A g h_A + m_B g h_B + \frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2$$

same = v

$$0 = m_A g h_A + m_B g h_B + \left(\frac{1}{2}m_A v^2 + \frac{1}{2}m_B v^2\right)$$

$$0 = m_A g h_A + m_B g h_B + \frac{1}{2}(m_A + m_B)v^2$$

$$0 = 3(9.8)(0.3) + 5(9.8)(-0.3) + \frac{1}{2}(3+5)v^2$$

$$0 = 8.82 + (-14.7) + 4v^2$$

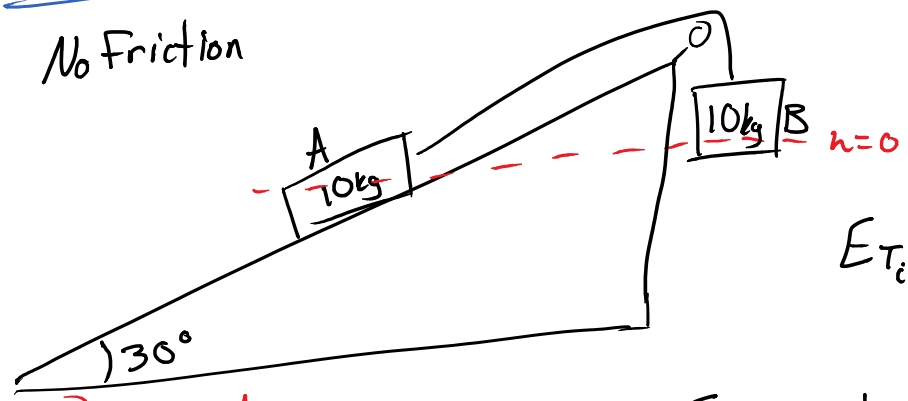
$$v = 1.21\text{m/s}$$

$0 = 8.82 + (-14.7) + 4v^2$

$\frac{5.88}{4} = \frac{4v^2}{4} \rightarrow v^2 = 1.47$

$v = 1.21 \text{ m/s}$

No Friction



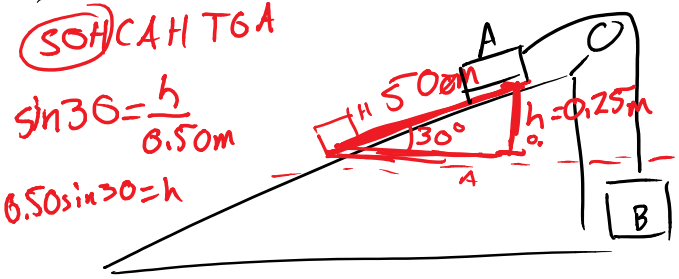
What is the velocity when B drops 50cm? Starts at rest.

$E_{T_i} = 0$

SOH CAH TOA

$\sin 36 = \frac{h}{0.50\text{m}}$

$0.50 \sin 30 = h$



$E_{T_f} = m_A g h_A + m_B g h_B + \frac{1}{2}(m_A + m_B)v^2$

$= 10(9.8)(0.25) + 10(9.8)(-0.50) + \frac{1}{2}(10+10)v^2$

$0 = 24.5 - 49 + 10v^2$

$\frac{24.5}{10} = \frac{10v^2}{10}$

$v = \sqrt{2.45}$

$v = 1.57 \text{ m/s}$