Chapter 11

Work Energy Theorem

\[ \Delta K = W - \Delta U \quad \text{In this case, there is no change in potential energy} \]

\[ \Delta K = W \]

\[ \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2 = -fl \]

\[ \frac{1}{2}mv_0^2 = fl = \mu_k F_n l = \mu_k mg l \]

\[ \mu_k = \frac{v_0^2}{2gL} = \frac{(1.2m/2)^2}{2(0.8)(2m)} = 0.037 \]
CHAPTER 11

\[ m = 100 \text{ kg} \]
\[ k = 8 \times 10^4 \text{ N/m} \]
\[ x = 0.5 \text{ m} \]

\[ \text{PE}_{\text{spring}} = \frac{1}{2} k x^2 \]

**THE SPEED when the Poisson Loses Contact**
with the spring can be found by analyzing the energy of the spring system.

Initially, the energy is **All Potential**

\[ E_i = \text{PE}_{i} = \frac{1}{2} k x_i^2 \]

Finally, all the energy is **Kinetic**.

\[ E_f = \frac{1}{2} m v^2 \]

**USING CONSERVATION OF ENERGY**

\[ \Delta K = W - \Delta U \implies \Delta K = -\Delta U \quad \text{if} \quad W = 0 \]

\[ k_f - k_i = \text{PE}_f - \text{PE}_i \]

\[ k_f + \text{PE}_f = k_i + \text{PE}_i \]

\[ \frac{1}{2} m v^2 = \frac{1}{2} k x^2 \]

\[ v^2 = \frac{k}{m} x^2 \]

\[ v = \sqrt{\frac{k}{m} x} = \sqrt{\frac{8 \times 10^4 \text{ N/m}}{100 \text{ kg}}} (0.5) = 14.14 \text{ m/s} \]
Let's find the velocity at the lowest point.

\[ E_i = \frac{1}{2} m v_0^2 + m g h \]

\[ E_f = \frac{1}{2} m v^2 \]

\[ E_f = E_i \]

\[ \frac{1}{2} m v_0^2 + m g h = \frac{1}{2} m v^2 \]

\[ v_0^2 + 2 g h = v^2 \]

where \( v_0 = 14.14 \text{ m/s} \)

\[ v^2 = \frac{v_0^2 + 2 g h}{1 + \left( \frac{14.14}{2 \times 9.8} \right)^2} \]

\[ v = 19.89 \text{ m/s} \]

Now, find how far the mass goes.

\[ \Delta E = W \]

\[ E_i = \frac{1}{2} m v_0^2 \]

\[ E_f = m g h_f \]

\[ \Delta E = m g h_f - \frac{1}{2} m v_0^2 = -m_k m g l \cos \theta \]

Use \( \sin \theta = \frac{h_f}{l} \Rightarrow l \sin \theta = h_f \)

\[ m g l \sin \theta = -\frac{1}{2} m v_0^2 = -m_k m g l \cos \theta \]

Solve for \( l \)

\[ \frac{v_0^2}{2} = g l \sin \theta + m_k m g \cos \theta \]

\[ l = \frac{v_0^2}{g (\sin \theta + m_k m g \cos \theta)} = \frac{(19.89)^2}{2 \times 9.8 \times (\sin(30^\circ) + 0.15 \cos(30^\circ))} = 32.04 \text{ m} \]