Friday Quiz
January 09
The two blocks I and II shown above have masses $m$ and $2m$ respectively. Block II has an ideal massless spring attached to one side. When block I is placed on the spring as shown, the spring is compressed a distance $D$ at equilibrium. Express your answer to all parts of the question in terms of the given quantities and physical constants.
a. Determine the spring constant of the spring.

\[ F_S = kD \quad F_G = mg \]

\[ F_S = F_G \]
\[ kD = mg \]
\[ k = \frac{mg}{D} \]
b. When the velocity of each mass is the same, they are not separating at that time and that occurs when the spring compression is *maximum*.

At any other time, one of the masses is traveling faster than the other and the spring is either compressing or expanding.
c. Determine the maximum compression of the spring during the collision.

At maximum compression:

From conservation of momentum

\[ P_i = P_f \]
\[ mv_o = (m + 2m)v' \]
\[ mv_o = (3m)v' \]
\[ \frac{v_o}{3} = v' \]
c) From conservation of Energy

\[
\frac{1}{2} mv_o^2 = \frac{1}{2} kx^2 + \frac{1}{2} (3m) \left( \frac{v_o}{3} \right)^2
\]

\[
\frac{1}{2} mv_o^2 = \frac{1}{2} kx^2 + \frac{1}{6} mv_o^2
\]

\[
 mv_o^2 = kx^2 + \frac{1}{3} mv_o^2
\]

\[
kx^2 = mv_o^2 - \frac{1}{3} mv_o^2
\]

\[
kx^2 = \frac{2}{3} mv_o^2
\]

\[
x^2 = \frac{2mv_o^2}{3k}
\]

\[
x = v_o \sqrt{\frac{2m}{3k}}
\]

\[
x = v_o \sqrt{\frac{2m}{3 \frac{mg}{D}}}
\]

\[
x = v_o \sqrt{\frac{2D}{3g}}
\]
d. Determine the velocity of block II after the collision when block I has again separated from the spring.

\[ p_i = p_f \]
\[ K_{Ei} = K_{Ef} \]
\[ mv_o = mv_{1f} + 2mv_{2f} \]
\[ \frac{1}{2} mv_o^2 = \frac{1}{2} mv_{1f}^2 + \frac{1}{2} (2m)v_{2f}^2 \]

This two statements are necessary to validate the use of the following equation.
\[ v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i} + \frac{m_2 - m_1}{m_1 + m_2} v_{2i} \]

\[ v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i} \]

\[ v_{2f} = \frac{2m}{m + 2m} v_o \]

\[ v_{2f} = \frac{2}{3} v_o \]