Problem 3 (20 points):

Tension in rod =

$m_1 = m \quad m_2 = 3m$

Spring, friction less rod

~~Initially~~ Conservation of energy: $\Delta E_{mech} = 0$

Find V of each block

~~momentum~~ $K_i + U_{el,i} = K_f + U_{el,f}$

~~(m+3)~~ $\frac{1}{2}(4m)V_0^2 + \frac{1}{2}k(l_0)^2 = \frac{1}{2}(m)V_1^2 + \frac{1}{2}3mV_2^2$ **

$\frac{4}{2}3mV_0^2 + \frac{1}{2}k(l_0)^2 = \frac{1}{2}mV_1^2 + \frac{3}{2}mV_2^2 \Rightarrow 4mV_0^2 + k(l_0)^2 = V_1^2 + 3V_2^2$

Conservation of momentum:

$(m_1+m_2)V_{0,i} = m_1V_{1i} + m_2V_2$

$4mV_0 = mV_1 + 3mV_2$

$4V_0 = V_1 + 3V_2$

$V_{1,f} = \frac{2m_2}{m_1+m_2}V_{2,i} + \frac{m_1-m_2}{m_1+m_2}V_{1,i}$

$V_{1,f} = \frac{6m}{4m}V_0 + \frac{-2m}{4m}V_0$

$= \frac{3}{2}V_0 - \frac{1}{2}V_0 = V_0$

$V_0 = 0$

Use c.o.m. reference frame → $V_{cm} = 0$

$0 = V_1' + 3V_2' \qquad kl_0^2 = V_1' + 3V_2'$

$V_1' = -3V_2'$

$V_{2,f} = \frac{2m_1}{m_1+m_2}V_{1,i} + \frac{m_2-m_1}{m_1+m_2}V_{2,i}$

$= \frac{2m}{4m}V_0 + \frac{2m}{4m}V_0 = V_0$

$4V_0' = 3V_2' \quad 4V_0' + kl_0^2 = 3V_2'$

$kl_0^2 =$

Solution:

Equation is, now:

$\frac{1}{2}k(l_0)^2 = \frac{1}{2}mV_1'^2 + \frac{1}{2}(3m)V_2'^2$

Substitute $V_1' = -3V_2'$

$k(l_0)^2 = m(-3V_2')^2 + 3m(V_2')^2$

$k(l_0)^2 = 12mV_2'^2$

$V_2' = \sqrt{\frac{kl_0^2}{12m}} = \frac{l_0}{2}\sqrt{\frac{k}{3m}}$, $V_1' = -3V_2' = -\frac{3l_0}{2}\sqrt{\frac{k}{3m}}$

8 Return to the reference frame of figure 2, add V_0

$V_1 = V_0 - 3\frac{l_0}{2}\sqrt{\frac{k}{3m}}$

$V_2 = V_0 + \frac{l_0}{2}\sqrt{\frac{k}{3m}}$