(c) Define the total mass M and the reduced mass m.

$M = m_1 + m_2$

$m = \dfrac{m_1 m_2}{m_1 + m_2}$

(d) Write the Lagrangian in terms of the coordinates R and r.

$L(R, r; \dot{R}, \dot{r}) = \frac{1}{2} M \dot{\vec{R}}^2 + \frac{1}{2} m \dot{\vec{r}}^2 - \frac{1}{2} k \vec{r}^2$

(e) Solve the equations of motion for arbitary initial conditions R^0, V^0; r^0, v^0 at $t = 0$.

$R(t) = \vec{R}^0 + t \vec{V}^0$

$r(t) = \vec{r}^0 \cos \omega t + \dfrac{\vec{v}^0}{\omega} \sin \omega t$

$\omega = \sqrt{k/m}$

$\frac{d}{dt} \frac{\partial L}{\partial \dot{R}_i} - \frac{\partial L}{\partial R_i} \Rightarrow M \ddot{R}_i = 0$

$\frac{d}{dt} \frac{\partial L}{\partial \dot{r}_i} - \frac{\partial L}{\partial r_i} \Rightarrow m \ddot{r}_i + k r_i = 0$

(More room for work on next page)