Here, * means natural units, as opposed to SI.

$$\eta_{H_2O} \approx 1.0 \times 10^{-3} Pa \cdot s = 1.0 \times 10^{-3} \frac{kg}{m \cdot s} \tag{1}$$

$$1 \text{ RESTLEN} = 1m^* = 1 \times 10^{-7} m \rightarrow \eta_{H_2O} \approx 10^{-10} \frac{kg}{m^* \cdot s} \tag{2}$$

$$\tag{3}$$

Young's modulus of actin is approximately $10^9 Pa$, so

$$1Pa^* = 10^9 Pa \rightarrow \eta_{H_2O} \approx 10^{-12} Pa^* \cdot s = 10^{-12} \frac{kg^*}{m^* \cdot s^{*2}} \cdot s \tag{4}$$

$$\tag{5}$$

Then, the ratio between both of these values for the viscosity of water should be 1, so

$$1 = \frac{\eta_{H_2O}}{\eta_{H_2O}} = \frac{10^{-12} \frac{kg^*}{m^* \cdot s^{*2}} \cdot s}{10^{-10} \frac{kg}{m^* \cdot s}} = 10^{-2} \frac{kg^*}{kg} \frac{s^2}{s^{*2}} \tag{6}$$

$$\rightarrow \frac{kg^*}{kg} = 10^2 \frac{s^{*2}}{s^2} \tag{7}$$

At this point, I can't think of a way to separate mass from time. My assumption: **for now, I am just letting** $1kg^* = 1kg$. Then,

$$\frac{s^*}{s} = 10 \sqrt{\frac{kg^*}{kg}} = 10 \tag{8}$$

$$\rightarrow \eta_{H_2O} = 10^{-13} Pa^* \cdot s^* \tag{9}$$

Then, for an order of magnitude calculation, we see that the velocities due to Hookean forces is about

$$\frac{10^{-3} \text{ forces are generally around this value}}{6\pi(10^{-13})(10^{-1})} \sim 10^{10} \tag{10}$$

$$\tag{11}$$

This implies that the time step needs to be less than $10^{-10} s^*$ by at least an order of magnitude, but I can't believe this is right, is it?