

Physics 480: Homework #3
Due November 17, 2010
10 points

1. (3 points) A cell is initially in an isotonic solution. The osmolarity of the solution is 50 mM. If the cell is placed in pure H₂O, will the cell membrane rupture? The radius of the cell is 10 μm and the maximum surface tension the membrane can withstand before rupturing is $\Sigma=10^{-3} \text{ Nm}^{-1}$. Assume only H₂O can pass through the membrane and the radius of the membrane stays constant.
2. (3 points) The file 'SimDiff.mat' contains a data set which is the observed location vs time, $x(t), y(t)$, for a diffusing particle. The time interval between steps is 10 ms and the position information is in units of 100 nm (this is around the back-projected pixel size of a typical CCD camera when used in a fluorescence microscopy setup). Calculate and show a MSD(Δt) plot. Fit the MSD(Δt) to extract the diffusion constant, the magnitude of the drift velocity, and the standard deviation of the measurement error. Submit your m-code via e-mail.
3. (4 points) A length of double stranded DNA (dsDNA) is cut using restriction enzymes such that it has 1000 bases on each single strand. The persistence length is $A = 50 \text{ nm}$. Write a MATLAB code that generates a particular configuration of the polymer when an applied force at the end of the DNA is $f = 0, 0.1, 1, 10 \text{ pN}$. Assume the polymer chain can be made out of very small ($L \ll A$) lengths and that the bending energy can be taken as that from a Hooke model. Submit your m-code via e-mail.