Physics 227
Homework 6 - Due March 6, 2009

Problem 1: In class, we derived the fact that the diffusion constant D is given by $D = \mu kT$, where μ is the mobility. This result hold in general, even when our simple calculations in class do not apply. To show this, we suppose that there is a density gradient, giving rise to a current. We now apply a force field, so that each molecule feels a force F. We now adjust F, so that it just balances the diffusion, so there is *no net flow* of molecules. Under these conditions, we will have a steady (time-independent) density of molecules, ρ. Find it. Is this consistent with our results from kinetic theory? What can you conclude?

Problem 2: Consider diffusion with constant D. (a) Use Fourier methods (on space and time) to solve for the density of diffusing particles if the initial distribution is a delta function, $\rho(x, t = 0) = \delta(x)$. Do the same if the initial density is uniform in a square of size L. (b) Repeat part (a) if there is also a drift velocity v. Make plots of your results at different times. (hint: Use techniques you learned in quantum mechanics).